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FINAL REPORT

Evaluation of the Atlantic Canada Opportunities Agency's Innovation and Technology Priority

J2206

May, 2000

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1 Introduction

This report presents the results of the evaluation of ACOA's Innovation and Technology (I&T) initiatives in the non-commercial sector. Specifically, initiatives during the period of 1991 to 1999 were reviewed. This evaluation was conducted by ***Applied Management Consultants***.

1.1 Purpose and Objectives

Although the purpose of this study was not specifically outlined in the Terms of Reference, it can be defined as follows:[1]

> The evaluation emphasis is to be given to the large effort made by the Agency to provide a research infrastructure and support to the Innovation and Technology investment. The Agency has invested several millions of dollars, annually into universities, research centres, and business associations to provide an I&T support infrastructure and an environment encouraging the business community to invest in new and innovative products, services and processes.
>
> The evaluation will look across programs and across the Atlantic regions in order to assess the overall achievements as well as results or benefits to the Atlantic businesses or region. Among the issues identified, the evaluation will investigate areas of significant gaps, areas of duplication or competition and type of complementarity that could be achieved.

The objectives for this evaluation assignment were:

1. To complete an evaluation of the I&T priority focusing on results and impact. Although the original evaluation framework contained 21 issues to address, it was decided early on in the project to focus on the following six main issues:

    a. Should ACOA continue to finance University research centres? Would it be better to help businesses directly and get them to pull out innovation support from

[1] Request for Proposal - Evaluation of the Atlantic Canada Opportunity Agency's Innovation and Technology Priority, Solicitation #3X001-9-1012/A, Appendix A

universities instead of universities trying to push innovation in firms? What impact have universities had on the private sector firms?

b. Linkages between the centres - Are innovation or research centres competing or complementary to one another? Are there exchanges between centres to help each others' growth?

c. Long-term impact - Some non-commercial centres have received assistance for a long time period. What results have been achieved in this long time period?

d. Cluster case studies - What was done? Were there linkages between regions to benefit from experiences and lessons learned?

e. Advocacy/Coordination issues.

f. What is ACOA contributing over and above the "National Program".

2. To provide, under separate cover, specific recommendations on actions which the Agency should take in order to improve its support to the I&T priority of Atlantic SME and business research structure or community. This has been incorporated into this main report.

1.2 Objectives of ACOA's Innovation and Technology Priority

The period covered by this evaluation extended from 1991 to 1999. During this timeframe the objectives for I&T have been redefined. Presently, the objectives are:

1. To increase diffusion of best-practice technology by firms in Atlantic Canada.

2. To assist with the development of technology-based goods and services by Atlantic Canada SMEs.

3. To facilitate technology development and diffusion through infrastructure support for SMEs.

4. To support the development of regionally strategic sectors.

5. To strengthen the science and technology culture in Atlantic Canada.

1.3 Nature and Extent of ACOA Support

* During its existence, ACOA has provided financial assistance to support innovation throughout Atlantic Canada. In addition to its direct funding to companies ACOA has provided support to the infrastructure that supports innovation.

* Each regional office has worked diligently to develop and sustain a high quality infrastructure to support innovation. In addition to financial assistance, ACOA has been a broker and facilitator often helping various groups to access funding from other sources. In some cases this has been facilitated by some direct funding support as well.

* There is no one formula for how ACOA has supported the innovation infrastructure. Some examples include:

  Project specific support - where the proponent and ACOA collaborated on a specific initiative with specifically identified expectations.

  Capital funding - where ACOA supported the acquisition of specific pieces of equipment or building of facilities intended to provide the proponent with the infrastructure to undertake R&D support related to a specific area (e.g. CAD/CAM equipment).

  Operating funding - to support the general operations or in some cases to support specific types of operations. In addition, operating funding is generally for durations of 1 to 5 years.

  Comprehensive funding - provided proponents a combination of funding for capital and to support operations.

* Each of the four regions has employed a variety of these different funding mechanisms.

* The funding levels for support varied greatly from a few thousand dollars to tens of millions of dollars.

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* The basic program logic for these funding initiatives is as follows:

1. ACOA provides funding for capital and/or operations of a non-commercial centre.

2. The centre develops innovations that can be commercialized by SMEs.

   AND/OR

   The centre provides innovation support services (e.g., contract R&D) to SMEs where these would otherwise not be available.

3. The SMEs build and sell the related products and services thus creating local economic benefits.

1.4 Methodology

Measuring the performance of I&T initiatives includes a blend of measures intended to capture both the qualitative and quantitative aspects of performance. In particular, we measured the following performance characteristics:

Leverage Generated - we endeavoured to determine the multiplier effect applied to the ACOA funding. This allowed us to ascertain the direct effect the funding had upon the research centres/institutes as well as the economic spin-off to the region.

Direct Outcomes - we endeavoured to determine the extent to which the R&D conducted by the research centres/institutes was commercialized and the economic impact that was created.

Indirect Outcomes - we endeavoured to determine the extent to which the R&D conducted by the research centres/institutes indirectly led to discoveries, new services or products beyond what was initially anticipated. We attempted to determine what of these were commercialized and the economic impact that was created.

Activities Performed - we endeavoured to determine the specific activities that were performed

related to the funding provided. For example, these activities included technical assessments, assistance, reviews, seminars, etc. We will describe the impact these activities had.

We used a number of methodologies to determine the performance of ACOA supported I&T initiatives. These included:

1.4.1 Region-wide Research Centre/Institute Surveys

This was a four step process to gather detailed information from all the research centres/institutes in Atlantic Canada.

Step 1 *- Research Centre/Institute Survey Document Development and Testing* - we developed a comprehensive survey document designed to collect information pertinent to evaluating ACOA's I&T Priority and to directing the future of the I&T strategy. The survey document was reviewed with the evaluation committee prior to live testing with a small sample of research centres/institutes. **Appendix A** contains a copy of the survey instrument.

Step 2 *- Acclimatization Workshops* - were conducted in each Province. We held sessions in Halifax, Sydney, Charlottetown, St. John's, Fredericton and Moncton. The purpose of the sessions was to acclimatize appropriate representative(s) from research centres/institutes and support organizations that ACOA has supported through its I&T Priority. Each session required approximately one half day to complete. These sessions gave representatives the necessary background and tools to complete the comprehensive survey. **Appendix B** contains a list of centres invited and those participating in the survey.

Table 1 presents the sample frame for the survey. It provides the number of centres, total ACOA funding dollars and percentage of total ACOA funding dollars by population type (total population, sample population and respondent population). These dollar values reflect completed projects only as that was the group of projects recommended by the Steering Committee.

Table 1: Survey Sample Frame

Population Type	Number of Centres	ACOA $	% of Total ACOA $
Total Population	74	$112,458,227	100%
Sample Population	33	$99,046,127	88%
Respondent Population	21	$65,669,426	58%

Step 3 *- Survey Completion Follow-up* - a comprehensive survey document was distributed at the acclimatization workshops. In addition to providing representatives with a study team contact to clarify any necessary points we followed-up with each centre to ensure the completion of the survey document.

Step 4 *- Survey Audit Process* - we conducted an audit of a sample of surveys received to validate the contents of the survey.

The surveys were analyzed to determine:

* Performance: Leverage Generated; Direct Outcomes; Indirect Outcomes; Activities Performed
* Patterns of success or failure and lessons learned
* Suitable case study candidates.

1.4.2 Case Studies

Based on the information collected from the research centres, from supplementary reports and interviews, and from issues identified in Key Informant interviews (**Appendix C** contains a list of key informants) we conducted three case studies on a variety of topics and with different candidate centres. The case studies conducted were:

1. Canadian Centre For Fisheries Innovation - Case study of a centre in a traditional industry.

2. Best Practices - Case study on identifying the best practices of three regional centres:
   - Seabright
   - Concept+
   - In*NOVA*corp

3. Aquaculture Cluster - Case study to examine the support for a strategic cluster.

As part of the case study process, we developed selected Propagation Diagrams to depict the work of the centre, the relationships with other centres, and/or the spin-offs that were generated. The diagrams illustrate the multiplying effect of the work performed by a research centre and the linkages and collaboration that takes place. It demonstrates that the centre has an immediate impact on the companies with which it works and also on the industries and other companies that subsequently spin-off. The purpose of the diagrams is to present all of the relevant elements of the chain and to estimate the cumulative economic impact that they have.

1.4.3 Secondary Research

Various secondary documents were reviewed to supplement the information collected from the research centre/institutes survey and the case studies. These included:

- Previous studies and evaluations conducted of various research centres/institutes.
- Statistics Canada reports and data.
- Centre for the Study of Living Standards.
- Productivity data.

Appendix D contains a bibliography for the study.

1.5 Report Structure

Chapter 2 of the report provides an assessment of the specific evaluation objectives, including:

- Outcomes and Impact - leverage generated, activities performed and other indications of ACOA's impact.
- Linkages between the centres.
- ACOA's contribution over and above the "National Program".
- Advocacy/coordination issues.

Chapter 3 of the report describes the regional I&T strategies, research and development, and productivity GDP and trade in Atlantic Canada.

Chapter 4 discusses the challenges facing centres that support innovation in Atlantic Canada as well as any lessons that have been learned.

Chapter 5 discusses the strengths, weaknesses, opportunities, and threats related to I&T in the region. This chapter also provides the recommended strategic issues that ACOA should consider to strengthen efforts in I&T.

2 Assessment of Specific Evaluation Objectives

This section presents the evaluation's major findings. The section is organized according to the major issues to be addressed. Because of the similarities of issues "A" and "C", we have grouped them.

One of the biggest challenges in addressing the impact of ACOA's I&T initiatives stems from the lack of good records in the centres.

2.1 Outcomes and Impact

Evaluation issues "A" and "C" shown below both relate to outcomes and impact of research centres in the region. This section presents these impacts. The information on impacts is drawn from the case studies, from the survey and from numerous reports which are described in the bibiolography.

a. Should ACOA continue to finance University Research Centres: Would it be better to help businesses directly and get them to pull out innovation support from universities instead of universities trying to push innovation in firms? What impact have universities had on the private sector firms?

c. Long term impact - some non-commercial centres have received assistance for a long time period. What results have been achieved in this long time period?

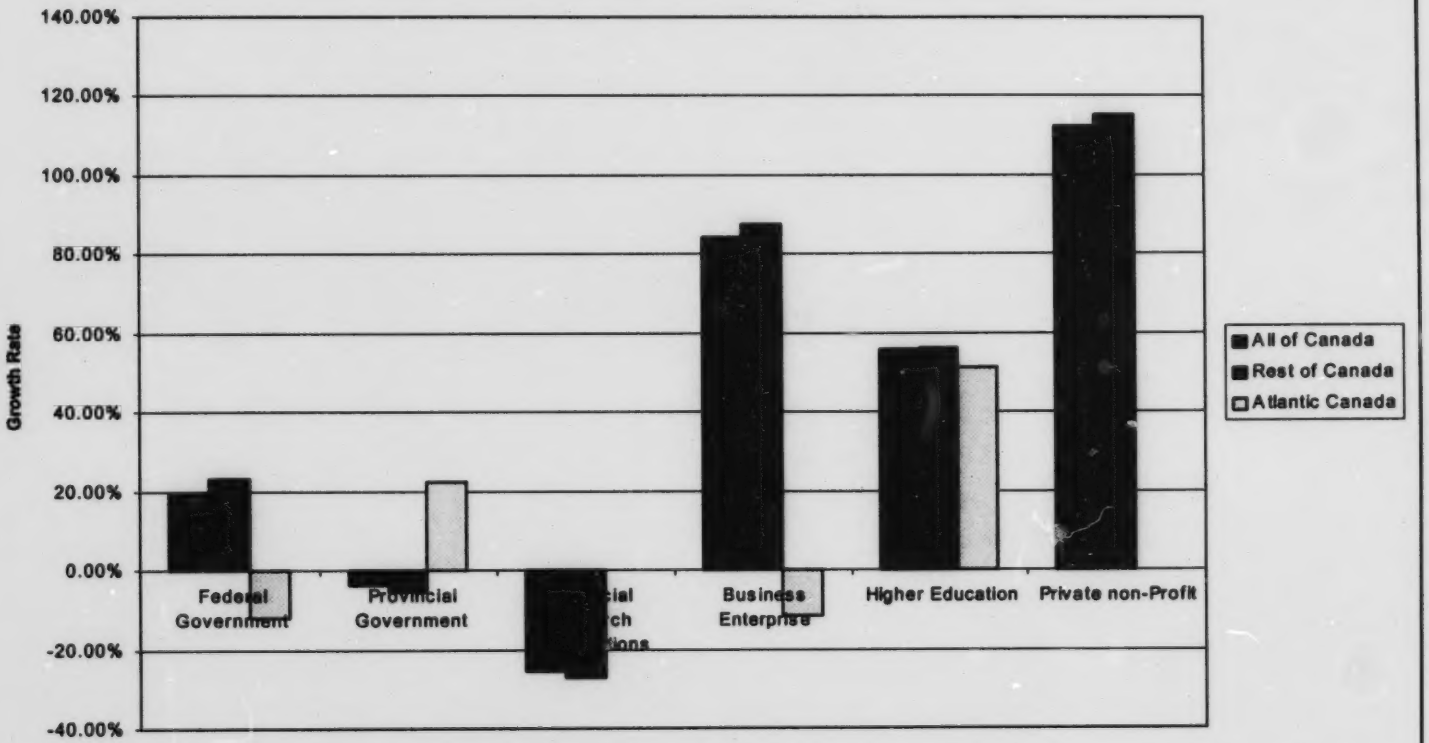
Key informants interviewed are virtually unanimous. Without major ACOA support, the significant research and development infrastructure now present in Atlantic Canada, with a few possible exceptions, would not exist. University key informants noted that cuts in university funding have severely constrained the ability of regional universities to make effective use of national research support. Without ACOA's funding support, much of the Canadian Foundation for Innovation funding would not have been accessed.

Table 2 and **Exhibits 1 and 2** show the percentage growth in GERD and in funding in the higher education. These confirm that the higher education sector in Atlantic Canada along with the Provincial Government have experienced growth. By contrast, the Federal Government's level of performance has declined. The decline experience in the Atlantic region is in distinct contrast to the increases in the rest of Canada and for Canada as a whole country.

TABLE 2: GERD Growth Rate by Sector and Higher Education Funding Growth by Source

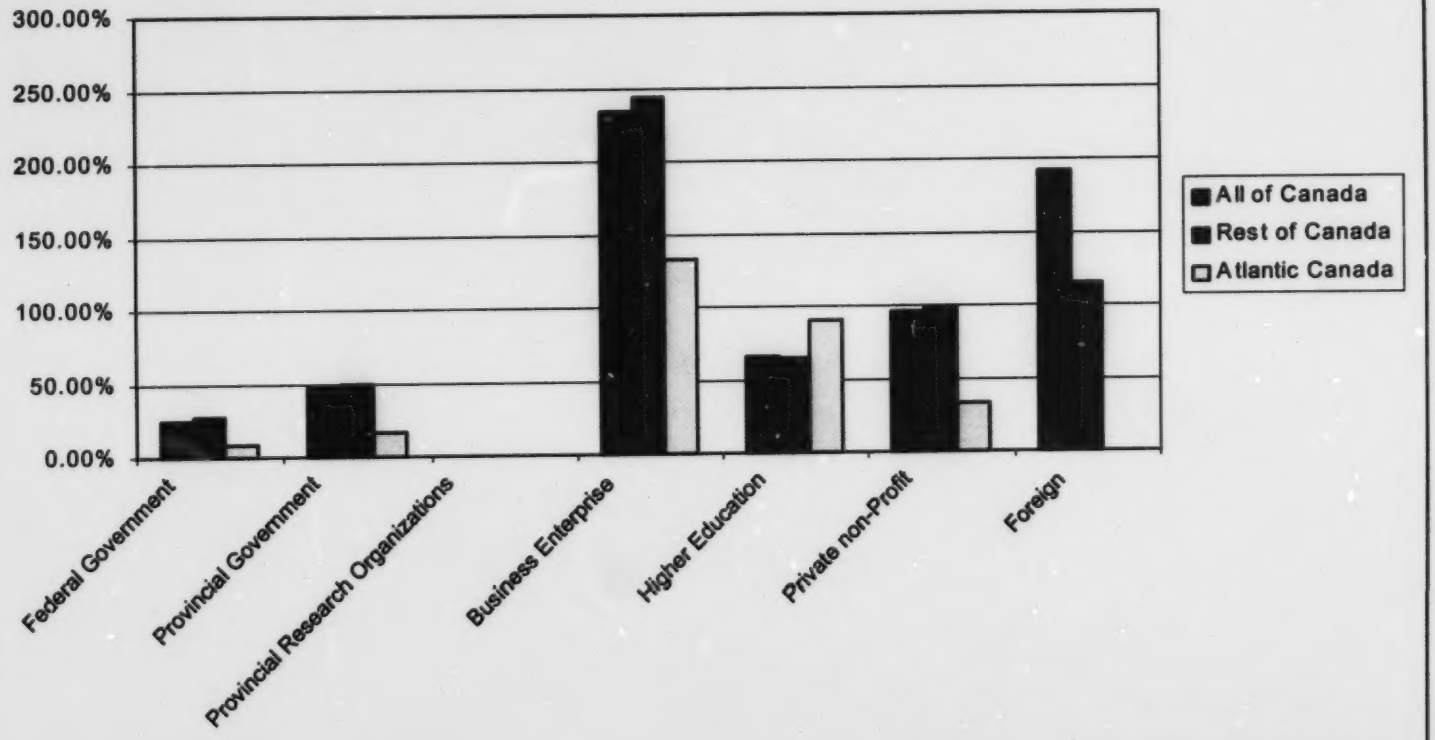
	National	Rest of Canada	Atlantic
GERD Sector Performing			
Federal Government	19.3%	23.0%	-12.1%
Provincial Government	-3.7%	-5.3%	22.2%
Provincial Research Organizations	-25.6%	-27.0%	--
Business Enterprise	84.3%	87.4%	-11.4%
Higher Education	55.8%	56.1%	51.2%
Private Non-Profit	112.4%	115.2%	--
Higher Education Sources			
Federal Government	25.2%	26.7%	8.7%
Provincial Government	48.1%	49.0%	16.7%
Provincial Research Organizations	--	--	--
Business Enterprise	234.9%	244.0%	133.3%
Higher Education	65.5%	63.9%	90.3%
Private Non-Profit	96.3%	99.2%	33.3%
Foreign	192.3%	--	--

EXHIBIT 1: GERD Growth Rates by Sector - Canada and Atlantic Canada (1988-1997)



Source: ***Estimates of Canadian Research and Development Expenditures (GERD), Canada 1988 to 1999, and by Province, 1988 to 1997,*** **Statistics Canada, Catalogue no. 88F0006XIB-99008**

EXHIBIT 2: Higher Education Funding Growth Rates by Source of Funding (1988-1997)



Source: ***Estimates of Canadian Research and Development Expenditures (GERD), Canada 1988 to 1999, and by Province, 1988 to 1997,*** **Statistics Canada, Catalogue no. 88F0006XIB-99008**

A closer examination of research performed by the higher education sector indicates that the contribution being made by the higher education sector have grown the largest in Atlantic Canada. As well, the growth in contribution by the Federal Government is significantly lower (8.7%) than that for the rest of Canada (26.7%).

The data and comments by key informants suggests that:

* Without the growth in research conducted by the region's universities, GERD in the region would have been lower.
* Without the support from ACOA for the universities, their growth would have been reduced and overall GERD for the region would have been negatively impacted.

Canadian Centre for Fisheries Innovation:

The Canadian Centre for Fisheries Innovation (CCFI), a non-profit organization, was established in 1989 by Memorial University of Newfoundland (MUN) and the Marine Institute (MI) to promote applied research and development in the fishing industry.

CCFI's activities in its second "mandate" - the period 1994 to 1999 - differed quite substantially from those undertaken during its first mandate (1989-1993). During this initial period, the fishing industry was in crisis. Groundfish landings which had accounted for 70% of landings value during the 1980's were in complete collapse. And, while Memorial University contained a strong research capability, it had very limited openings or linkages with industry. Consequently, CCFI's main role was to lay the foundation for fisheries and aquaculture R&D at the University and with the industry. Its main activities focussed on pioneering the sea urchin industry, researching cod grow-out farms, and initiating research on improving fish processing yield.

On the other hand, the second half of the nineties saw a fishing industry in transition, with shellfish now accounting for 80% of landed values. Memorial University was expanding its research capability substantially, especially in aquaculture, while industry was now developing a keen interest in R&D. Thus, in this second mandate, CCFI concentrated its research efforts on aquaculture (a full 50% of its projects and 45% of its expenditures were in this category) and crab and shrimp R&D.

Table 3 summarises the economic benefits anticipated from CCFI's investments in aquaculture as determined in the *Baird/Andrews* report.[2]

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[2]Baird Planning Associates and Andrews Port Services, *Evaluation of the Canadian Centre for Fisheries Innovation*, June 30, 1998.

TABLE 3: Predicted Impacts Of Selected Aquaculture Initiatives

AQUACULTURE	1998		POTENTIAL	
	Tonnes	Value	Tonnes	Value
Arctic Char	100	$1,000,000	2000	$12,000,000
Cod Grow-Out	50	$100,000	2000	$5,000,000
Mussels	1400	$1,900,000	4600	$6,000,000
Scallops				$5,000,000
Yellowtail Flounder			500	$2,000,000
Sea Urchins			500	$2,500,000
Halibut			3000	$24,000,000
Sub-total	**1550**	**$3,000,000**	**12600**	**$56,600,000**

By far the major contribution of CCFI to a much improved fishery industry is the pioneering work it did to prepare the inshore sector to take immediate advantage of recent significant increases in the Northern shrimp quotas, going from 3,700 tonnes in 1995 to 33,000 tonnes in 1998. Foreseeing the economic potential in shrimp, the Centre commissioned studies to address the technical, financial, and marketing questions relevant to harvesters and processors being able to realise this potential immediately. Using a comprehensive information package based on its research entitled, *Northern Shrimp: From Trawl to Table*, it held 2 major workshops focussing on the start-up and successful operation of a shrimp enterprise. These workshops were attended by almost 300 people paying $100 each, an unprecedented event in the fishery industry in Newfoundland. The unqualified opinion on almost everyone associated with the fisheries is that these efforts accelerated the economic exploitation of this new industry by at least one year, and more likely two.

The following highlights the expected outcome related to this new fishery:

* heightened industry readiness for new 33,000 tonnes inshore quota
* potential value - landings: $50 million; exports: $90 million
* jobs - 900 person-years in harvesting; 600 person-years in processing

Finally, one of the most important indirect outcomes of the activities of CCFI is the fact that its funds have led to the creation of some 40 temporary jobs each year for students as research assistants and technicians. The long term benefits of contributing significantly to the development of a highly skilled and experienced work force which will enhance the future of this industry should not be underestimated.

Exhibit 3 contains a propagation diagram that illustrates the partners with whom CCFI has worked and the impacts generated.

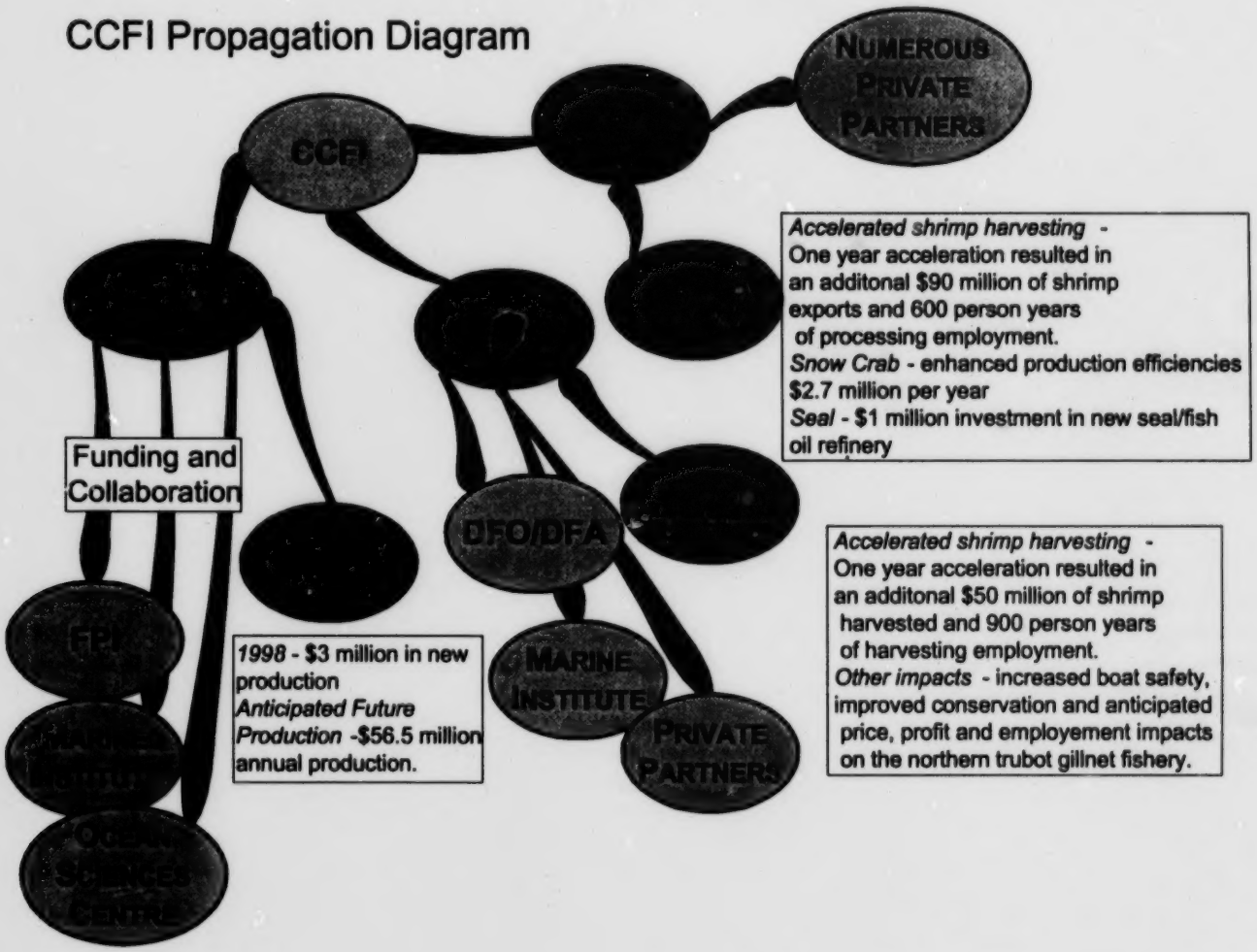
Seabright Corp. Ltd

Seabright Corporation is the technology transfer agency of MUN. Seabright's mission is to increase the economic benefits to Newfoundland and Labrador from research and development conducted at Memorial, as well as complement and support similar developments and activities at other educational institutions and in the private sector in this region.

Presently, there are 30 private sector jobs that have been created through the efforts of Seabright. This represents an estimated annual payroll of $1.5 million and tax revenues of $300,000. All of these jobs have been created in research and development as the spin-off companies continue to invest in product development.

The spin-off companies are all in the biotechnology field. The potential impact related to any one of these companies would translate into hundreds of jobs and millions of dollars of revenue for the Newfoundland economy.

EXHIBIT 3: CCFI Propagation Diagram


CCFI Propagation Diagram
NUMEROUS PRIVATE PARTNERS
CCFI
Accelerated shrimp harvesting - One year acceleration resulted in an additonal $90 million of shrimp exports and 600 person years of processing employment.
Snow Crab - enhanced production efficiencies $2.7 million per year
Seal - $1 million investment in new seal/fish oil refinery
Funding and Collaboration
DFO/DFA
FPI
1998 - $3 million in new production
Anticipated Future Production -$56.5 million annual production.
MARINE INSTITUTE
PRIVATE PARTNERS
Accelerated shrimp harvesting - One year acceleration resulted in an additonal $50 million of shrimp harvested and 900 person years of harvesting employment.
Other impacts - increased boat safety, improved conservation and anticipated price, profit and employement impacts on the northern trubot gillnet fishery.

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The focus of these companies is almost exclusively on creating products for world markets. Thus, their success will deliver significant new revenues to the region's economy.

TABLE 4: Seabright Assistance

COMPANY	EMPLOYMENT	ESTIMATED WAGE BILL	PERSONAL INCOME TAX REVENUES*
A/F Protein Canada	19	$1,000,000	$200,000
Terra Nova Biotechnology	13	$400,000	$80,000
Seafreez (Barry Group of Companies)	Not provided	Not provided	Not provided
Genesis Centre	5.5	$200,000	$40,000
Total	37.5	$1,600,000	$320,000

* Estimate based on 20% of payroll.

There remains a great deal of potential for the innovations that Seabright manages. The Clift report indicates the following statistics for the activities of the Corporation:

- 5 - Technologies licensed to industry
- 3 - Technologies under development with industry partners
- 6 - Technologies under evaluation
- 10 - Confidentiality agreements signed with companies
- 4 - Operating spin-off companies
- 4 - Alliance partnerships
- 4 - Canadian patents
- 17 - US patents
- 2 - European patents
- 22 - Patents pending

Concept+ Inc.

Established in 1983 by the Université de Moncton under the name CADMI Microélectronique, Concept+ Inc. is now a stand-alone, not-for-profit innovation centre, whose mission is to promote and transfer high technology to the private sector through the development of new products.

Concept+, and its predecessor CADMI, have made significant contributions to the regional economy. Together, it is estimated that the 45 companies, which make the most use of the centre's capabilities, have created more than 200 full-time jobs, generating a total wage bill of $7.5 million. Sales directly attributable to products and processes developed in conjunction with, or by Concept+ are estimated at $35 million annually. Of these, the six companies listed in **Table 5** below have all indicated they would not exist, but for the assistance, advice and support they received from the centre. More recent estimates offered by the centre's General Manager in the questionnaire prepared for this evaluation are 300 jobs and a wage bill of $10 million, with associated sales of roughly $50 million.

TABLE 5: Estimated Economic Impact Resulting from Concept+ Assistance

COMPANY	EMPLOYMENT	WAGE BILL	PERSONAL INCOME TAX REVENUES*
Spielo Gaming	100	$3,300,000	$660,000
Advantek Systems	6	$200,000	$40,000
Telemonitoring	8	$265,000	$55,000
Belltek Business Tech	4	$135,000	$25,000
Nanoptix	2	$70,000	$15,000
MicroOptics Systems	40	$1,320,000	$265,000
Other	67	$2,210,000	$440,000
Total	**227**	**$7,500,000**	**$1,500,000**

*Estimate prepared by Concept+ Inc., based on a 20% of total wage bill.

InNOVAcorp:

In*NOVA*corp was established in 1994 to grow Nova Scotia's knowledge economy through technology commercialisation and partnerships. In*NOVA*corp employs a staff of over 100 business, engineering and technical professionals experienced in providing an array of commercialisation and partnership services.

In addition to focussing its efforts on commercialisation, In*NOVA*corp in conjunction with partners from around the region are collaborating to expand the life sciences industry (through the Life Sciences Industry Partnership - LSIP) and to continue the excellent growth in IT that the province and region has experienced.

The anticipated and interim impacts of the LSIP are shown in **Table 6** below.

TABLE 6: Economic Impact Resulting From SLIP

Impact	EMPLOYMENT	WAGE BILL[3]	PERSONAL INCOME TAX REVENUES[4]
Anticipated over 3 years	540	$21,600,000	$4,320,000
Year 1 results from progress report	146	$5,840,000	$1,168,000

Many of the impacts of the efforts of the revitalised In*NOVA*corp are yet to be realised. The efforts related to LSIP call for a significant growth in the life science industries. Many of the equity investments that have been made are at an early stage.

The Quality and Prodictivity Initiative was one of the recent programs offered by In*NOVA*corp that was funded by ACOA through the Canada - Nova Scotia Technology Development Agreement. This program provided significant benefits:

- A total of 147 companies received ISO certification.
- According to "An Assessment of the Quality and Productivity Initiative" completed by Omnifacts: 77% of QPI participants attribute some or most of the benefits to the support received from QPI.

Aquaculture:

Exhibits 4 and 5 show the dollar value and tonnage of the aquaculture production in each of the Atlantic Provinces. These graphs show the significant growth that the industry has experienced.

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[3]Estimated based on $40,000 per job

[4]Based on 20% of wage bill

These graphs also highlight a marked decline in 1998 for New Brunswick that was related to Bacterial Kidney Disease.

The innovation supports, to which ACOA has contributed have created a sound resource that has not only supported the growth that has been evident, but will also protect the existing industry and support future growth.

Table 7 shows the estimated impact on jobs of the aquaculture industry in Atlantic Canada. It shows that an estimated 2100 people are directly employed in the industry. Additionally an estimated 1400 people are employed in the service and support of aquaculture.

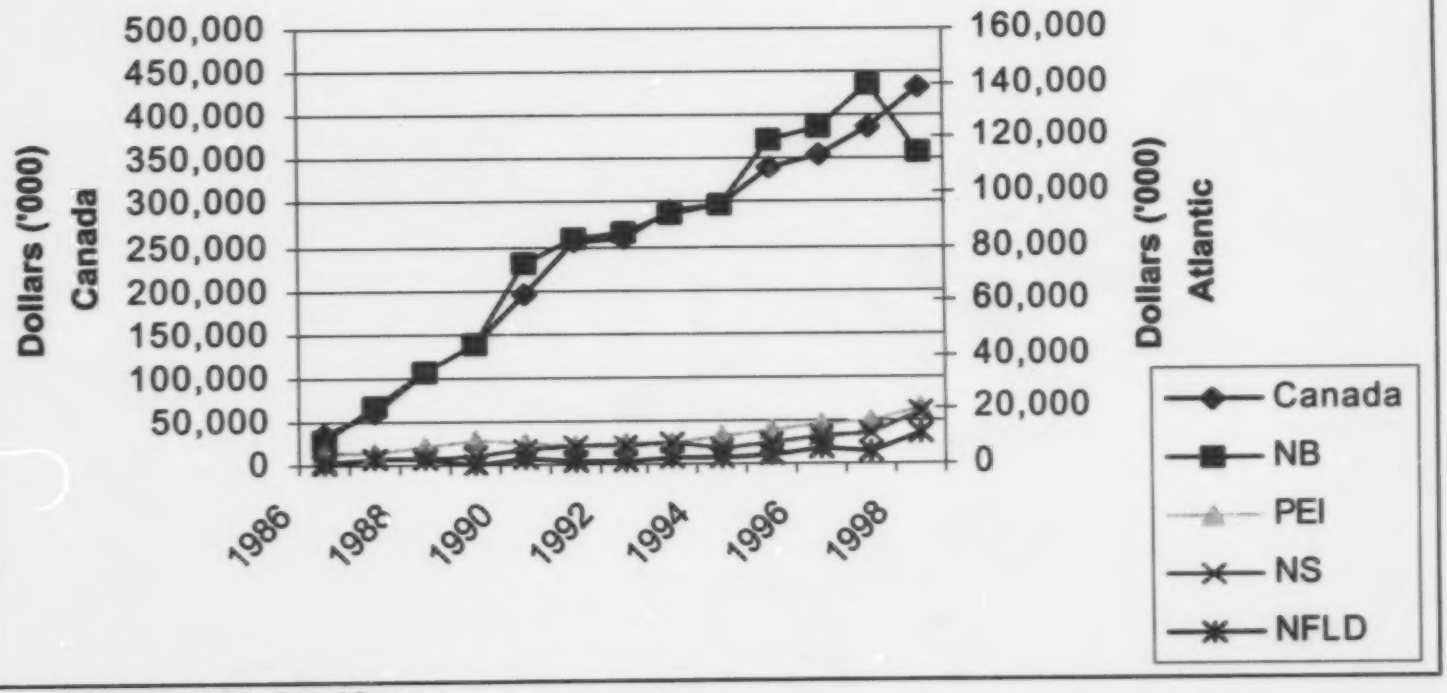
Table 7: Estimated Economic Impact of Jobs in Aquaculture (1998)

	Canada	New Brunswick	Prince Edward Island	Nova Scotia	Newfoundland
Direct Jobs	5000	1644	179	198	95
Indirect Jobs	3350	1101	120	133	64
Total	*8350*	*2745*	*299*	*331*	*159*

Source: Based on Pricewaterhouse Coopers *1998 Data Study* and Value Added Account Statistics from the Department of Fisheries and Ocean.

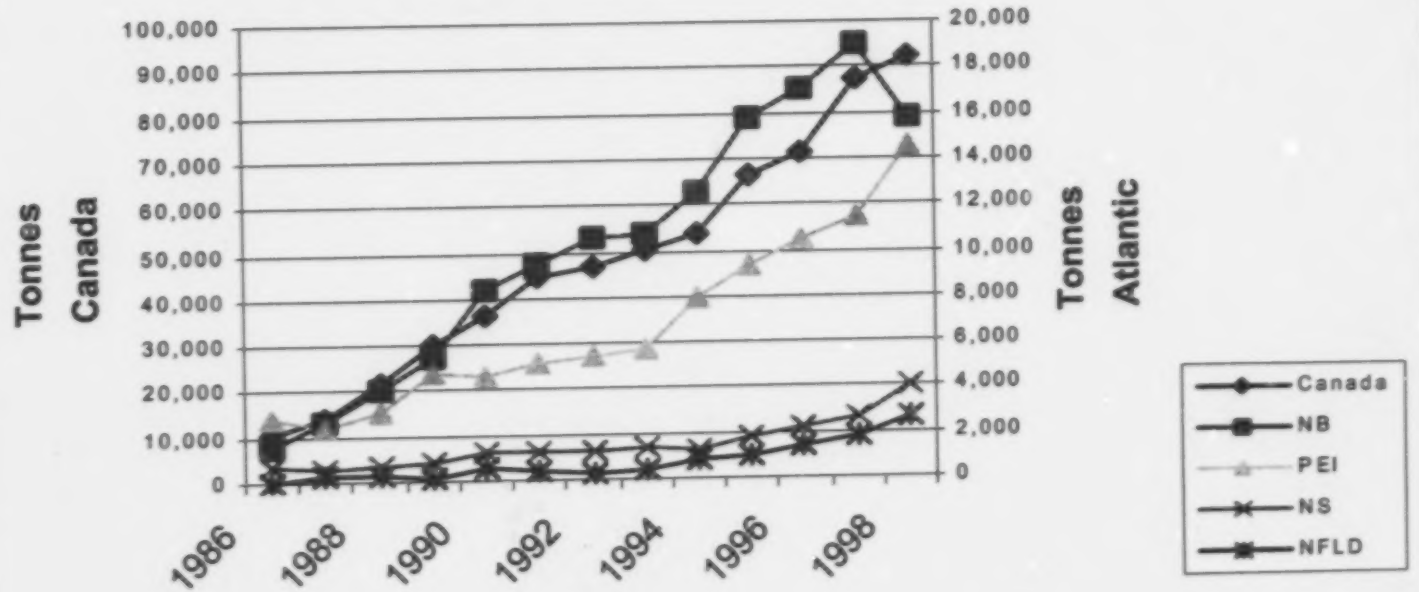
According to a national forecast by the Canadian Aquaculture Industry Alliance (CAIA), by the year 2005, finfish producers will double their existing production figures while shellfish producers anticipate a four-fold growth increase. Similar growth in Atlantic Canada is also expected. Keys to new growth will be sound research on alternative species, environmental research to allow for production increases and continued vigilance and research into fish health. These are all areas that are supported by the research infrastructure that ACOA has helped to put in place. The Huntsman Marine Sciences Centre, the Atlantic Veterinary College, RPC and CCFI represent a sound research infrastructure supporting this industry. Without this group of centres, future growth will be compromised.

Exhibit 4: Dollar Value of Aquaculture Production - Canada and Atlantic Provinces



Source: Department of Fisheries and Oceans

Exhibit 5: Tonnage of Aquaculture Production - Canada and Atlantic Provinces



Source: Department of Fisheries and Oceans

Exhibit 6 is a propagation diagram for the aquaculture industry. This diagram demonstrates the strong collaboration that exists among centres that support the industry. This diagram also demonstrates the important role that these centres play in protecting and supporting the growth of the industry.

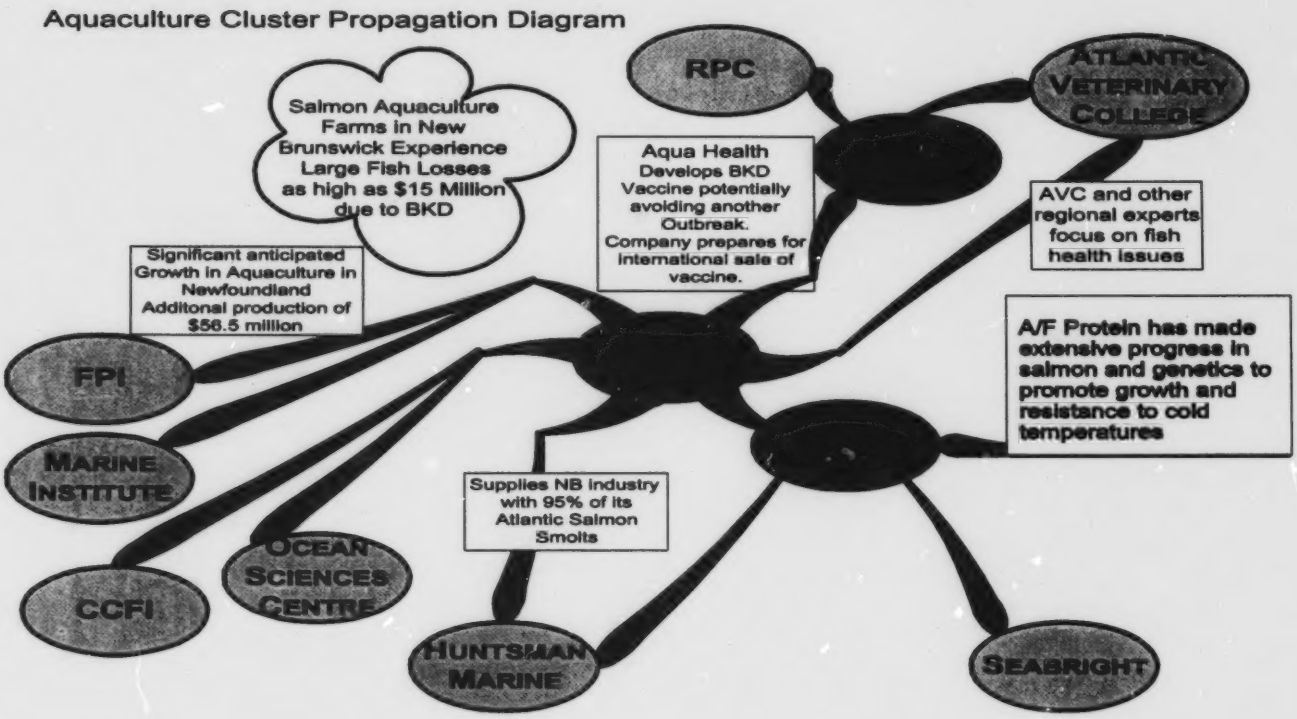
Other Centres in the Region:

Most of the research centres in our survey are well established groups that have been in operation for five, ten or more years. During that time, some of them have undergone a considerable metamorphosis, changing not only their mandate but also the fundamental services they offer. The impact that these centres have had has been through both one-on-one projects and through industry-wide initiatives.

Table 8 shows the various technologies/products generated by centres other than those included in the case studies. Completed questionnaires prepared for this study are the main source of this information. In the questionnaires, centres were asked to provide three or more specific examples of the impacts that they have had. Consequently, the impacts portrayed in this table are not intended to show the full extent of their impacts, rather they are to demonstrate the nature of their impacts. Where available, additional data was obtained from various evaluation reports and studies prepared for individual centres in recent years. In some cases, projections appear to be somewhat optimistic. However, they are included here because in most instances the full innovation cycle has yet to be played out.

Appendix B contains a listing of the centres identified in this study and the funding received for completed I&T initiatives during the 1991 to 1999 time period.

EXHIBIT 6: Aquaculture Cluster Propagation Diagram


Aquaculture Cluster Propagation Diagram
RPC
Atlantic Veterinary College
Salmon Aquaculture Farms in New Brunswick Experience Large Fish Losses as high as $15 Million due to BKD
Aqua Health Develops BKD Vaccine potentially avoiding another Outbreak. Company prepares for international sale of vaccine.
AVC and other regional experts focus on fish health issues
Significant anticipated Growth in Aquaculture in Newfoundland Additonal production of $56.5 million
A/F Protein has made extensive progress in salmon and genetics to promote growth and resistance to cold temperatures
FPI
Marine Institute
Supplies NB industry with 95% of its Atlantic Salmon Smolts
Ocean Sciences Centre
CCFI
Huntsman Marine
Seabright

Applied Management

TABLE 8: Various Technologies/Products Generated by Others Not in Case Studies

CENTRE	OUTCOMES/IMPACT
Atlantic Veterinary College (UPEI)	Most of the activities for which ACOA funding has been used is geared toward developing capacity within the University, to carry out research or service activities. Most private sector clients are not corporations, but industry groups such as the PEI Hog Commodity Marketing Board.
CADMI Micro-electronics Inc. (UNB)	Designed a microprocessor based temperature control system for domestic furnaces. Design and development of a Database Program to be used specifically in the Aquaculture industry. Design and development of various control systems for instruments used in biology and hospital laboratories. Redesign and manufacture of 120-lights driver printed circuit boards used in the sign board of the Moncton Coliseum.
Canadian Aquaculture Institute (UPEI)	Training function; no economic impact nor product development role identified.
Canadian Centre for Marine Communications (NFLD)	Development of a world leading capability in electronic chart technology; receptor company no longer in operation, however technology being exploited by other companies. Development of a software based radar processing technology which now forms the basis of the radar overlay capability on the ICAN electronic chart systems (technology marketed to the offshore petroleum industry and the aeronautical industry). Supported the development of a marine voyage data recorder (VDR), analogous to the black box carried by aircraft. Assisted Ultimateast Technologies (engineering and technical, facilities and equipment support) for a voice encryption product (Data Hail Radio), the MES-DTES product and the design, installation and implementation of the company's antenna array and supporting equipment in Tors Cove. Company now part of Aliant Telecom Group. Developed technology and reached agreement with Canadian Hydrographic Service under which spun-off company became the sole provider of Canadian hydrographic data to the world.
Canadian Centre for Marine Communications (NFLD) (cont'd)	Collaborated with Sigma Engineering Ltd on the development of SmarRadar, a project that developed unique neural network techniques to process and interpret large radar data sets; further collaborated in development of TITAN radar for advanced military application and RadarWAN re use of digital radio communications to relay radar signals. Collaborated in the development of a simulator for remotely operated vehicles (VROV) for operator training and mission rehearsal. A 1995 study estimated that the 20 new products developed with CCMC assistance would create 222 jobs and $77 million of economic activity, 80% in the export market (Clift Report).

CENTRE	OUTCOMES/IMPACT
Environmental Industries Research Laboratory (Université de Moncton)/Laboratoire de recherce pour l'industrie et l'environnement	Composting techniques in solid waste management. Optimization of composting plants as part of solid waste management. Analysis of contaminated site aimed at conversion to economic development. ACOA's contribution was to establish centre; no ongoing support.
Faculty of Engineering (Université de Moncton)/École de génie	Two-thirds of graduates were successful in finding employment in Atlantic Canada/only French language school of engineering outside Québec. Development of an in-vivo dosimetry system for the prostate brachytherapy based on scintillating fibre optics.
Centre de recherche des aliments (Université de Moncton)/Food Research Centre	Incomplete results.
Food Technology Centre (PEI)	In collaboration with a Montreal company, developed a crustacean processing technology (patent pending); anticipated a seafood plant in PEI will integrate technology in May 2000; will have multi-million dollar impact on the Atlantic lobster and crab processing industry over next 10 years. Co-sponsored the development of a world-class musk ox wool processing technology, leading to the establishment of speciality fibre processing mill in PEI. Innovated a fibre-optic environmental sampling device using leading edge Solid Phase Micro Extraction (SPME) technology, under an alliance arrangement with American and Ontario firms; prototype sampler to be constructed in PEI. A 1995 evaluation report concluded that products/technologies under development would create 80 full-time jobs and generate an additional $5.9 million in value-added.
GENESIS Centre (NFLD)	On-line music school allowing teachers and students anywhere in the world to work together. Creation of several patentable innovations in the guitar manufacturing process, and introduction of a new line of guitar. Development of an automated fuel dispensing system. Developed specialized word-processing software designed for the learning of disabled. Creation of a video game to educate children about asthma. Creation of patented dental implant for single-stage surgery. Creation of software package to develop and manage audit procedures. Estimates creation of 46 jobs and $295K sales.
Geographic Information System (GIS) Computer Centre (UNB)	Successfully designed, developed and tested geological mapping software to work in conjunction with CARIS (Computer Aided Resources Information System) GIS that continues to be the superior software from a conventional geological mapping point of view. Sole client is Universal Systems Ltd.

CENTRE	OUTCOMES/IMPACT
Huntsman Marine Science Centre (NB)	Collaborative arrangement with A/F Protein Canada leading to development of a superior, rapid growing broodstock of transgenic Atlantic salmon for aquaculture. A/F Protein Canada established facility in PEI for the commercial development of the transgenic broodstock under disease free conditions. Several collaborative projects with Connors Bros. Possible oral treatment for the removal of sea lice on Atlantic salmon. Computer simulation re proper sizing and placement of marine aquaculture equipment in Bay of Fundy. Feasibility of use of inter-tidal zone for salmon aquaculture. Study of the cost effectiveness of farm raising haddock as a line extension to Atlantic salmon. Development of necessary protocol required for commercial farming of shortnose sturgeon.
Huntsman Marine Science Centre (NB)	Operates the Atlantic Salmon Broodstock Development Program on behalf of 8 industrial partners representing 95% of NB salmon smolts requirements. Nearly one in four employees in Charlotte County rely on aquaculture for their livelihood. A/F Protein reports 19 jobs and roughly $150,000 in sales.
Research and Productivity Council (NB)	RPC's laboratory work has supported the development of New Brunswick's environmental services sector. One example is Jacques Whitford Environment Ltd. which has helped create 30 jobs, maintain 70 jobs and generated $15 million in revenues over ten years. Development of a prototype for local sports equipment manufacturer, this created 6 new jobs. Developed a public access internet terminal for a local company. This work created 15 new jobs. Development of a vaccine for Atlantic salmon. These include a vaccine for Hitra Disease and a patented vaccine Renogen for Bacterial Kidney Disease. On-going development is focussed on DNA vaccines. To date, this work has created 6 new jobs, maintained 26 jobs and grown sales revenue by $6 million annually.
Telemedicine Educational Resources Agency (NFLD)	A distance education course directed to emergency medical attendants and ambulance drivers throughout the province. Educational program to assist healthcare workers or family members to deal with chemotherapy patients. High school distance education program in 78 locations with enrolments of 1,000 students; also prepares students for a variety of post-secondary educational opportunities by providing access to advanced courses to be used for post-secondary credits. University courses that carry degree and certificate credit in a wide variety of subject areas, including criminology, business and mathematics. In collaboration with Nfld. Chapter of the Canadian Cancer Society and the Terry Fox Cancer Research Lab at MUN, delivers a breast cancer survivors network enabling dialogue surrounding any issue concerning breast cancer in all areas of the province. Continuing medical and nursing education credit courses for health practitioners in remote areas. Diabetes management program.
THL Inc. (NFLD)	Established to provide complete telemedicine or distance education services to international markets from the existing operations in Newfoundland. Now inactive.

CENTRE	OUTCOMES/IMPACT
UCCB CAD/CAM Centre (NS)	No data provided.
UCCB Technology Enterprise Centre (NS)	Financial data **not included** due to confidentiality agreements. Approximately 40 jobs created between 1998-2000.
Wood Science and Technology Centre (UNB)	Development of kiln drying schedules for pine. Development of innovative wood panels. Determining the mechanical properties of lumber. Trouble shooting/expert advice on product improvement and testing of wood I-joist products for product certification purposes. Identifying options for utilisation of sawmill wood residues. Development of glued laminated wood products made from green low-grade hardwood. Jobs created and maintained: (49).

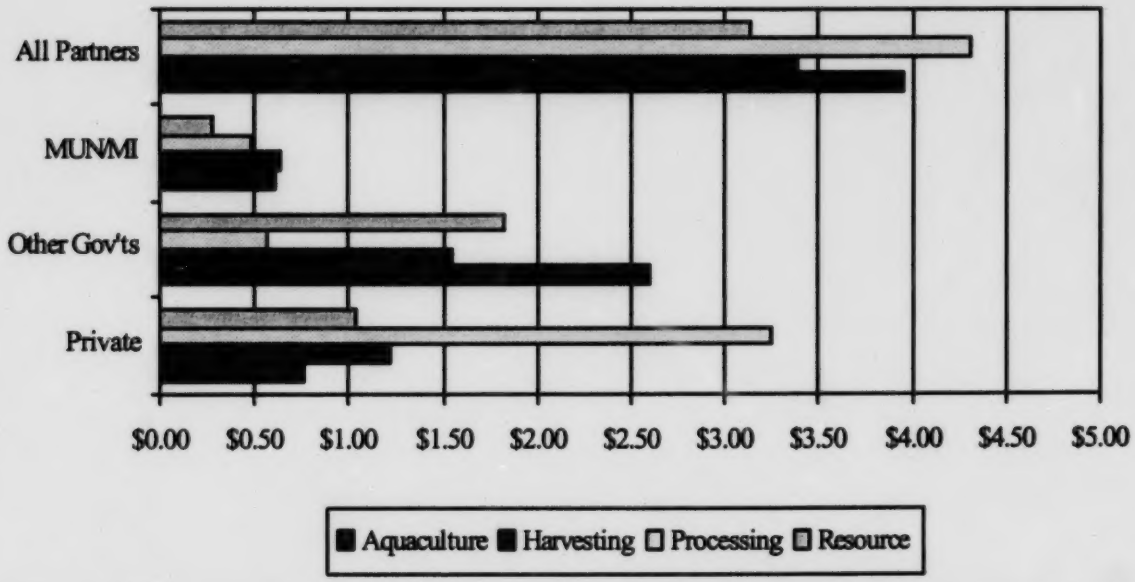
2.1.1 Leverage Generated

This section presents our findings about the leverage generated on ACOA's funding. The CCFI case study was able to go into sufficient depth to uncover this information. The leverage generated by CCFI illustrates the significant leverage potential of the research centres.

The *Baird/Andrews* report provides a comprehensive listing of R&D projects undertaken by CCFI over the period 1994-1998. The total value of these projects is some $22 million. CCFI contributed roughly $4.5 million (20.7%), while its partners in the private sector accounted for 29.2% of total funding ($6.3 million). Other government agencies (mainly, the Aquaculture component of the Economic Renewal Agreement, the National Research Council, the Department of Fisheries and Oceans, and the Newfoundland Department of Fisheries and Aquaculture) contributed 37.7% ($8.2 million). MUN/MI provides 12.4% ($6.3 million). **Exhibit 7** indicates the leverage achieved by every $1.00 invested by CCFI in each of its major activity areas (Aquaculture, Harvesting, Processing, and Resources).

Overall, it is clear that CCFI is most effective in leveraging investments in R&D in this traditional industry. Indeed, its partners spend nearly $4.00 for every dollar spent by the Centre, almost double the requirement under CCFI's contribution agreement with ACOA.

EXHIBIT 7: Leverage Achieved by Every $1.00 Invested by CCFI in Each of Its Major Activity Areas



Source: ***Evaluation of the Canadian Centre for Fisheries Innovation*****, was prepared by Baird Planning Associates and Andrews Port Services (*****Baird/Andrews*****), June 30, 1998**

The following examples are offered in the *Baird/Andrews* report as instances where the Centre took a proactive and leading role, conceiving and leading projects which would not have proceeded without its participation: the halibut and flounder aquaculture projects, the sea urchin ranching initiative, the information initiative for the shrimp industry, and the turbot longlining work. Similarly, CCFI's partnership with ten processing companies in an R&D initiative aimed at innovations to increase crab meat quality and yield is offered as a further example where collective efforts provided enormous dividends through spreading the cost and bringing sufficient resources to bear on projects.

Table 9 below further describes CCFI's leveraging of private sector investments by breaking down its contribution by project size and major category.

TABLE 9: 'Best Bang' for One CCFI Dollar

Project Size	Aquaculture	Harvesting	Processing	Resource	Total
Less than $10,000	$1.06	$1.39	$3.83	$17.18	$2.92
$10,000 - $25,000	$0.78	$1.96	$1.15	$0.47	$1.09
$25,000 - $50,000	$0.48	$1.56	$1.58	$0.43	$0.97
$50,000 - $100,000	$0.73	$0.61	$1.74	$0.34	$0.84
More than $100,000	$1.00	$0.36	$11.52	$0.00	$3.56
TOTAL	*$0.88*	*$0.77*	*$3.24*	*$1.03*	*$1.40*

CCFI is most effective in leveraging private sector dollars when it comes to very small projects in all categories, small and medium size projects in the harvesting category and all projects regardless of size in the processing category. Clearly, **Exhibit 7** and **Table 9** demonstrate that CCFI has been quite effective in striking a balance between projects aimed at short-term commercialization (substantial private sector investment) and long-term development (public sector partners).

2.1.2 Activities Performed

Table 10 presents a summary of the activities of the centres. **Appendix E** contains a more complete description of the centres' mission statement, main products and services, and impacts and outcomes.

TABLE 10: Summary of Centres' Activities

Centre	Mission Statement	Products/Services
Atlantic Veterinary College (UPEI)	AVC is the only institution in Atlantic Canada educating Doctors of Veterinary Medicine, and one of only four veterinary colleges in Canada. The College is fully accredited by the Canadian Veterinary Medical Association, the American Veterinary Medical Association and the Royal College of Veterinary Surgeons. AVC graduates consistently achieve high success on professional licensing examinations and have excellent employment opportunities around the globe.	Speciality units include the Animal Productivity and Health Information Network, the Laboratory of Veterinary Pharmacogenetics, the Equine Sports Medicine Centre, the Animal Welfare Unit, and the Lobster Health Research Centre. The College also operates the Cardigan Fish Hatchery in eastern PEI, a swine research facility in Union Road, PEI and is affiliated with the Metro Emergency Animal Clinic in Halifax, Nova Scotia. The AVC has 24 laboratories equipped for biomedical research. The Diagnostic laboratories (bacteriology, clinical pathology, endocrinologoly, necropsy, parasitology, toxicology, and virology) as well as the Fish Health Facility provide additional resources for research on fish and mammalian diseases. Strong collaborative arrangements have been established with many livestock and fish producer organisations in the region. This has led to the opportunity to carry out extensive field-based research on animal health and productivity.
CADMI Microelectronics Inc. (UNB)	To provide high level state-of-the-art microelectronic design services to small NB businesses, both for product development and for improvement of industrial processing.	Computer-aided design and simulation of microelectronics circuits. Software design and development. Microelectronic design and implementation. Design of printed circuit boards. Design of very large integrated (VLSI) circuits. Feasibility studies on applications of microelectronics. Conducting introductory and advanced technical courses on microelectronics, fibre optics, digital communications and topics in computer aided design of microelectronics circuits.

Centre	Mission Statement	Products/Services
Canadian Aquaculture Institute (UPEI)	As a joint initiative of UPEI and Holland Community College of PEI, CAI is a division of AVC Inc. established to provide provincial, national and international continuing education in aquaculture medicine, fish health and management.	Development and delivery of training courses in following: selective breeding, effective disease diagnosis and treatment, site selection, proper nutrition, and good husbandry and management practices. Courses are directed to all groups involved in the industry including hatchery and farm operators, veterinarians, researchers, government officials, investors, bankers and private sector service providers. Consulting services provided by faculty from the Atlantic Veterinary College on contract basis.
Canadian Centre for Marine Communications (NFLD)	Dedicated to the technical and commercial development of marine products and services using advanced communications, navigation and information technology in co-operation with government and industry.	All development activities are undertaken within a framework of three programs: *SmartShip* (shipboard information technologies); *Infomarine* (content and applications) and *SeaComm* (communications media and bandwidth). Specific initiatives include: *Information Seaway* (extension of 'information highway' offshore; *Marine Geomatics* (focus on offshore hydrocarbon industry); *Marine Intelligent Systems* (marine applications of robotics and intelligent systems) and *Marine Information Skyway* (development and commercialisation of enabling technologies and marine applications for satellite communications).
Environmental Industries Research Laboratory (Université de Moncton)/Laboratoire de recherce pour l'industrie et l'environnement	To promote the creation of new "environmental" industries. Assist industry to meet environmental standards. Improve production systems through chemical analysis. Evaluate economic potential of new technologies. In conjunction with relevant governmental agencies, develop new environmental standards and analysis.	Chemical analysis (heavy metals, organic contaminants, water quality analysis). Consulting services (solid waste disposal, composting, industrial production). Applied research (development of new methods for chemical analysis and industrial technologies).
Faculty of Engineering (Université de Moncton)/École de génie	To provide undergraduate course program in electrical engineering. Only professionally accredited French language school of engineering outside Québec.	Faculty members contribute their expertise to various research centres associated with the university such as Concept+ Inc.
Food Research Centre (Université de Moncton)/Centre de recherche des aliments	Undertake research and development in the food industry and provide consulting services to the food processing industry in Atlantic Canada, with a special emphasis on NB. The main focus is small and medium-sized companies with a view to strengthen the regional food processing industry.	Support services to R&D performers in the food industry through product development, chemical, microbiological and sensory analysis. Services are provided in both official languages. The centre has obtained ISO 9002-94 certification for its chemical and microbiological analytical capability.

Centre	Mission Statement	Products/Services
Food Technology Centre (P.E.I.)	Generate enhanced wealth for Prince Edward Island through new economy innovation, applied research and development, technical support and strategic alliances in the food industry.	Product development on contract. Process development. Pilot plant facilities – CFIA approved and export status. Sensory evaluation facilities. Troubleshooting (analytical lab services). Chemistry/microbiology laboratories facilities. Information retrieval. International level technology alliances. ISO 9001 approved.
GENESIS Centre (NFLD)	To ready companies for significant private investment, by guiding their development of a comprehensive business plan, an experienced management team, and a capable diverse Board of Directors.	Match firm with a world-class mentor (usually a Newfoundlander) who has started, or managed a high growth technology business outside province (Operation MENTOR). Assistance to develop business plan. Physical resources such office space and support.
Geographic Information System (GIS) Computer Centre (UNB)	Computer Centre maintained and marketed by Universal Systems Limited of Fredericton.	Development of spatial geological mapping software to be compatible with CARIS (Computer Aided Resources Information System) GIS. Development of CARIS++ - exchanging the old Fortran programming language for C+ object coding.
Huntsman Marine Science Centre (NB)	Act as a research and development centre/laboratory for renewable marine resources, particularly for Aquaculture, and also as a training centre/educator for private industry's staff. Membership includes: Atlantic Salmon Federation, DFO, McGill University, Mount Allison University, NRC, NB Department of Education, NB Department of Fisheries and Aquaculture, Saint Mary's University, University of Guelph, Université de Moncton, UNB, University of Toronto, and University of Western Ontario.	University and high school credited courses. Aquaculture: protocol development and technology transfer. Atlantic Reference Centre: identification and classification of cold water fisheries and other marine organisms and the identification of environmental effects of aquaculture. Environmental atmospheric monitoring: only coastal site in Atlantic Canada.
Research and Productivity Council (NB)	Main purpose is to provide contract research and technical services to industry in New Brunswick in order to help firms expand and produce high quality employment opportunities.	Food product development and analysis, microbiological analysis, DNA diagnostic, fish health research. Routine and non-routine analytical services in organic and non organic chemistry. Management strategies in forestry, agriculture, mineral process development. Design and manufacture of prototype metal and plastic products. Research and development of remote inspection devices, calibration, precision machining, physical metallurgy. Software development, e-commerce solutions, delivery of IRAP.

Centre	Mission Statement	Products/Services
Telemedecine Educational Resources Agency (NFLD)	As an entity within the Faculty of Medicine at MUN, we facilitate the use of information technology and telecommunications in the delivery of health and education services to non-urban, remote and isolated areas on a provincial, national and international scale.	Teleconference network (divided in 11 separate teleconferencing circuits servicing a total of 247 sites in approximately 160 communities). Medical data transfer (services include remote nuclear medicine, tele-elecroencephalogram, tele-ultrasound and tele-radiology). Audio graphics (electronic blackboard used for freehand writing or drawing in real time, or to display computer-based graphic pages). Video conference (services via terrestrial compressed video technologies as well as IP via satellite). Consulting and training (program design and development, feasibility studies, training, testing of new types of distance programs, etc.).
THL Inc. (NFLD)	Market products and services to international markets. Develop new communication products and services in the areas of telemedicine and distance education. To act as champion and leader on strategic alliance projects in this sector assembling provincial and national expertise.	Provide complete telemedicine or distance education services to international markets from the existing operations in Newfoundland. To consult on new installations of these services internationally, or to enter into joint ventures in this area. Lead a consortium of local companies that developed a low cost, enhanced bandwidth RSDN system.
UCCB CAD/CAM Centre (NS)	The Centre provides CAD/CAM support for eastern NS enterprises in the following areas: CAD programming Operation training CAD/CAE training Part prototype design and manufacture CAD/CNC communications Robotics, CAM programming and operation training Post-processor development assistance Vision incorporation in the manufacturing cell CAD software development	Conceptual design (solid modelling) of parts. Operational design and analysis (stress, materials…). Part prototype manufacturing. Batch mode production machining. Custom quality control template design and manufacture. Parts quotes based on design for production. Materials selection and optimisation. Custom industrial training courses. Employee recommendations. Industrial research and development. Industrial liaison to promote Eastern NS.
UCCB Technology Enterprise Centre (NS)	Provides early-stage technology-based companies with incubation support services to facilitate product commercialisation.	Provides facilities, administrative services, business services and technical services to in-house clients.
Wood Science and Technology Centre (UNB)	Provides R&D and testing services to the wood products industry on a fee-for-service basis. It is one of only three nationally certified wood product research and testing centres in this country and the only one in Atlantic Canada.	Product R&D. Evaluation and testing of products. Process improvement. Feasibility studies on new products. Market studies. Development of quality control system.

2.1.3 Other Indications of ACOA's Impact

The impact of ACOA's support for innovation is reflected in the comments that have been obtained from key informants and research groups and from the examples of economic impact that is related to the funding that ACOA has provided.

* Broad based initiatives such as the Quality and Productivity Initiative resulted in 147 confirmed implementations of quality and productivity improvements (ISO registrations). A report completed by Omnifacts Research, *"An Assessment of the Quality and Productivity Initiative"* stated that 77% of firms felt that support from QPI was responsible for some or most of the benefits they have experienced.
* The revitalization of the New Brunswick Research and Productivity Council (RPC), which received a significant financial contribution from ACOA, has transformed the organization from one that was highly dependant on operating grants to one that now only receives a small operating grant. ACOA's support has allowed RPC to transition itself and the services it provides making it more responsive to the needs of the NB economy.
* Innovation and R&D are long term processes. In some cases taking 5 to 10 years to show their impact. To have a significant impact, many of the centres in the survey believe they have to play a sustained role in their efforts. According to several centres, funding uncertainty and delays in approving applications has had the following impact on their operations; 1) it has affected their ability to recruit and retain highly skilled staff and 2) it has affected their ability to attract partners and collaborators.
* The Canadian Centre for Fisheries Innovation was instrumental in the development of the shrimp fishery in northern Newfoundland. CCFI completed a key research project that developed fishing equipment suitable to this environment. For two years after this project there appeared to be no net benefit. Subsequently, this fishery has grown into a $300 million annual business and is a significant contributor to the Newfoundland economy. Because CCFI had long term core funding it was able to deliver the benefits of its efforts.
* According to our survey, centres supporting innovation are facing real financial difficulties. Dealing with the conflicting objectives of becoming self-sufficient and of supporting regional economic development (by supporting local SMEs) is placing a definite strain on some centres. To support regional economic development these centres must pay a real price because local SMEs generally do not have the resources to quickly and fully capitalize on the efforts of the centre. A few centres have indicated that in order to fund their operations and keep staff they have started to sell their capabilities internationally. Foreign funding sources represent a growing proportion of GERD funding, suggesting that the region's research capabilities are world class. This trend also

represents a challenge to maximizing local benefit on research and intellectual property.

* Centres in the survey who are dealing with SMEs noted a reduction in the volume of business arising from local entrepreneurs since ACOA altered its policy on the repayability of its funding to companies. Many local entrepreneurs are risk averse. With this change in policy, some centres have indicated that local entrepreneurs are no longer able to accept the risks associated with undertaking an innovation effort.

2.2 Linkages Between the Centres

One of the key elements of impact that ACOA sought to have was to increase the linkages between the different groups in the research and innovation support community. As well, ACOA sought to improve the linkages between this community and the private sector. Evaluation issue "B" is below.

b. Are innovation or research centres competing or complementary to one another? Are there exchanges between centres to help each others' growth?

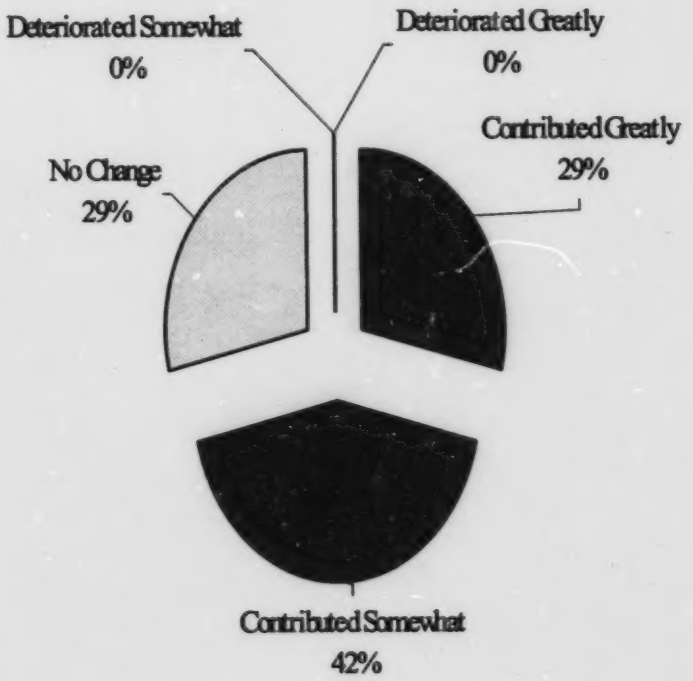
Exhibit 8 shows ACOA's contribution to the linkages with other centres as perceived by survey respondents. The key points from this diagram are as follows.

* 71% of respondents indicated that ACOA had contributed to improving the linkages with other centres in the region.

* Some commented that many of the groups with whom they interact and to whom they have linkages were supported or established by ACOA.

* In several cases, more than one centre has worked with and supported a private client. Some examples are Seabright, the Marine Ocean Sciences Centre and Huntsman Marine Institute who have all worked with A/F Protein to develop and commercialize its products; RPC and the Atlantic Veterinary College who have both worked with Aquahealth; CCFI and the Marine Institute who worked jointly on a number of projects.

Exhibit 8: Contribution of ACOA to the Linkages with Other Centres - Survey Participants



* While centres listed numerous other regional centres as their competitors there is a general sense of collaboration among many of the centres and groups.

* Collectively there is a greater critical mass when all the centres are present. Small centres especially recognize the need for critical mass.

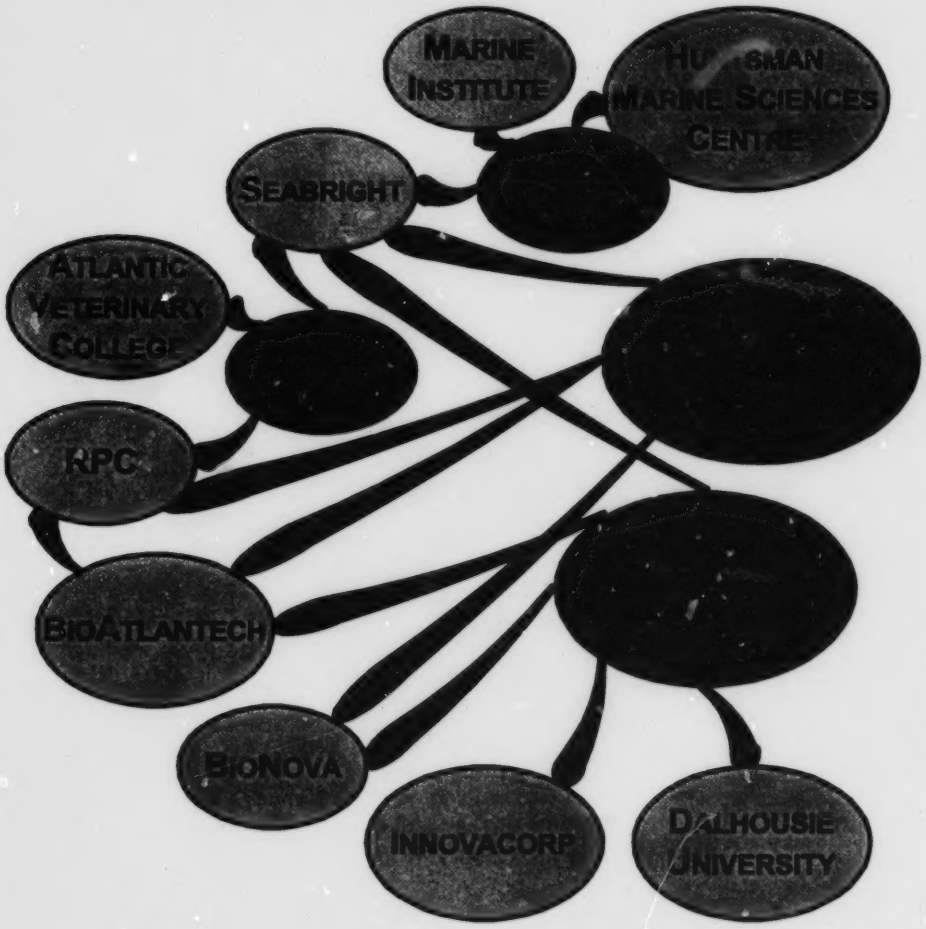
* Respondents noted that ACOA has been a strong advocate for these linkages funding both organizations and events whose purpose is to bring together the centres and industry.

* ACOA both through its direct support of centres and through its networking and event sponsorship has improved linkages between centres and between centres and the private sector.

Exhibit 9 is a propagation diagram for Seabright that specifically demonstrates the linkages of this centre.

* The diagram clearly demonstrates the many linkages that centres in the region maintain.
* ACOA's funding and efforts have created an environment where these linkages are possible. By creating sufficient critical mass of centres and by funding certain initiatives that help to bring them together, ACOA has strengthened linkages.

EXHIBIT 9:
Example of Linkages of Various Centres in the Region



Applied Management

2.3 Supporting a Cluster

The aquaculture cluster was used as an example of the potential effort of supporting a cluster. The evaluation is listed below at "D".

d. What was done? Were there linkages between regions to benefit from experiences and lessons learned?

* The expansion of the aquaculture industry has been supported by R&D and innovation support from a range of groups across Atlantic Canada. These groups include: Atlantic Veterinary College, Canadian Aquaculture Institute, Canadian Centre for Fisheries Innovation, Huntsman Marine Sciences Centre, and RPC.

Atlantic Veterinary College

* The Atlantic Veterinary College (AVC) supports the industry through specialized research such as the collaborative work with RPC and Aqua Health to discover a vaccine for Bacterial Kidney Disease in salmon. As well, through their regular diagnostic services AVC supports the industry in fish health and disease management. AVC will play a vital role in the recently announced Fish Health Surveillance program announced by the New Brunswick Salmon Growers Association. AVC along with growing community of fish health experts, research scientists, and veterinarians will provide professional support while ensuring that consistent and up-to-date methods of disease management are followed. This is an increasingly important contribution to what is now New Brunswick's largest food "crop".

  This type of support is vital to the long term sustainability and growth of the industry.

Canadian Aquaculture Institute

* The Canadian Aquaculture Institute's objective is to assist aquaculture throughout the world through the development and delivery of training courses. These professional training courses, workshops, and seminars are designed for all groups involved in the industry including: hatchery and farm operators, veterinarians, researchers, government officials involved in policy development and program administration, investors, bankers, and individuals from private sector industries that provide services to the aquaculture industry.

Huntsman Marine Sciences Centre

* The Huntsman Marine Science Centre is a membership-driven, non-profit organization founded in 1969 by a consortium of 20 universities in Eastern Canada (with support from

the National Research Council of Canada, Fisheries and Oceans Canada and the New Brunswick Department of Fisheries and Aquaculture). The mandate of Huntsman's Aquaculture Department is to provide the industry with a centre for research, training, and service. In addition to maintaining research strengths with respect to Atlantic salmon, including transgenics and improvement of other salmonoids such as Arctic charr, emphasis is currently focused on the development of alternate species for marine aquaculture. Candidates under investigation are various flatfish including yellowtail and winter flounders, striped bass, haddock, and pollock.

* The work it performs on alternative species and on alternative production methods are key to the continued growth of the industry.
* Huntsman's aquaculture program areas include activities within the following areas:
    1. Teaching
    2. Research and Development
    3. Industrial Service
    4. Technology Transfer
    5. Evaluation and Testing

RPC

* RPC's Food, Fisheries and Aquaculture Department provides research, development and analytical expertise on a fee-for-service basis to clients in business and government concerned with the development of the aquaculture, food and seafood industries.
* RPC provides a range of services to the industry:
    - The Molecular Biology Group serves the aquaculture industry through the development and application of fish health diagnostic techniques for pathogen screening, and through the formulation of vaccines and other therapeutants for fish health protection. Diagnostic techniques developed and applied to farmed Atlantic salmon are now being adapted for detection of pathogens in haddock, halibut, sturgeon, and others.
    - The molecular biology laboratory feature state-of-the-art instrumentation for DNA/RNA analyses, genetic analyses, gel electrophoresis and documentation, and protein characterization. Our facilities also include virology and bacteriology laboratory suites, as well as freshwater and marine fish quarantine units.
* The Food and Seafood Team specializes in the development of innovative new products, designing improvements to existing products, and assisting clients in finding ways to reduce production costs through ingredient, processing and/or packaging alterations.

Members of the team also undertake in-plant problem solving, process line development, QA/QC program development, and production equipment modification and commissioning.

* As noted in Section 2.1 (pages 15-19), the aquaculture cluster has experienced significant economic growth.

2.4 What is ACOA Contributing Over and Above the "National Program"

This section discusses ACOA's involvement in the centres and what it has contributed beyond the "National Programs". Evaluation issue "E" is listed below.

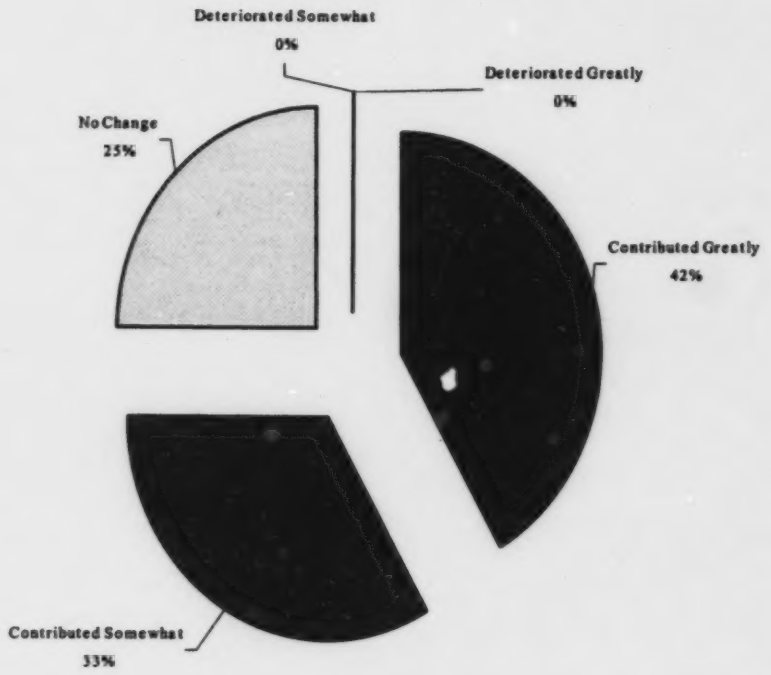
e. What is ACOA contributing above and beyond the National Programs?

* ACOA's funding of non-commercial research centres was designed to encourage the research community to focus more closely on the needs of industry and SMEs. In this regard, ACOA's funding is unique amongst federal programs for these centres.
* The application of research capability from universities and into companies is the most significant additional contribution that ACOA has made.
* ACOA's funding has built local research infrastructure that can make other federal programs such as IRAP more viable. Many clients of these centres are believed to have received IRAP funding to develop prototypes. Without these centres, much of this development work likely would not have been undertaken.
* Centres such as CCFI, CCMC, Concept+, CADMI and others are working much closer to industry than universities traditional work. While universities traditionally focus on "pure research" (where most other funding is targetted), these centres have taken and applied the capabilities of universities toward development for industry.
* **Exhibit 10** shows ACOA's contribution to linkages with the private sector as perceived by survey respondents. 75% of respondents indicated that ACOA had contributed to improving the linkages with the private sector. The majority of those respondents indicated that they contributed greatly to improving these linkages.
* While university research centres have moved closer to industry as a result of ACOA's funding, the receptor capacity of the region is an obstacle to more and accelerated development of the links with industry.

2.5 Advocacy/Coordination Issues

* Key informants indicated that ACOA actively sought ways to leverage the funding of other programs and groups.
* One specific example is BioAtlantech. This centre operates with an endowment of $2 million equally funded by the New Brunswick Department of Agriculture and Rural Development, and Agriculture and Agri-food Canada. Leveraging off of the funding of these other departments, ACOA was able to fund initiatives directed toward industry and economic development. As a result of this coordination of effort, BioAtlantech has spun off two start-up companies: Solanum Genomics and Vaccinium Technologies Ltd.

Exhibit 10: Contribution of ACOA to the Linkages with the Private Sector - Survey Participant



3 I&T in Atlantic Canada

Appendix F contains our detailed findings on the state of I&T in Atlantic Canada.

3.1 Regional Strategies

Each of the four Regional offices has employed a strategy that is oriented toward the needs of the region. A brief discussion of the different strategies that were employed in each region follows.

3.1.1 Nova Scotia Region

* ACOA has worked diligently to elevate the level of innovation that exists in the region. ACOA has worked particularly closely with In*NOVA*corp and its predecessor the Nova Scotia Research Foundation. In*NOVA*corp has been a key delivery mechanism for many large programs including the Technology Development Agreement.

* In addition to providing support for infrastructure, ACOA recognized and responded to some of the key issues facing the region, for example, the need to strengthen the private sector's ability to receive, adopt and use new innovations. Consequently, ACOA supported industry associations to strengthen receptor capacity, supported an industry led training organization to strengthen the human resource elements, provided broad based industry initiatives like Technical Partners in Industry and the Quality and Productivity Initiative. More recently ACOA has supported province-wide initiatives to place computers in schools to increase computer literacy for tomorrow's graduates, employees and employers.

* ACOA recognized the need to support the commercialization of intellectual property from universities. By providing funding to create Nutech, ACOA supported organizations whose general purpose is to take what has been created in some regional universities and generate economic spinoffs.

3.1.2 New Brunswick Region

* ACOA had a close working relationship with the Province, with the province's universities, and with research organizations. ACOA's strategy has been to work closely with these partners to collaborate on the development of the provincial economy. This collaboration included the revitalization of the New Brunswick Research and Productivity

Council (RPC) from an organization that was highly dependant on annual government grants to one that receives only a small annual grant. ACOA recognized the long-term nature of innovation and has continued its support of such groups as the Centre de Reserche sur les Aliments, Wood Science Technology Centre and other established groups.

* ACOA has worked well to support and leverage the efforts of others. For example, ACOA supported BioAtlantech a group that was formed by Agriculture and Agri-Food Canada and the New Brunswick Department of Agriculture and Rural Development. BioAtlantech was formed to be a catalyst to the development of the biotechnology industry in the province. ACOA's involvement with these other partners has led to the establishment of two new companies with a bright future. Furthermore, ACOA helped to support the development of a biotechnology diploma program within the New Brunswick Community College system. This program graduates trained technicians who can provide companies with skilled resources.
* In addition, ACOA NB worked closely with its provincial counterparts to meet the needs of industry by increasing the number and calibre of graduates to work in the province's growing IT sector.

3.1.3 Newfoundland Region

* ACOA supported the creation and continued operation of numerous large centres and initiatives. A key element of their strategy has been to provide long term funding arrangements that provide improved stability for the centre and the people involved. While the centres and initiatives that have been supported represent a new level of innovation, they are largely oriented toward the province, its economy and its strengths.
* The Newfoundland situation was very different from the other regions. While other regions were seeking to improve upon the infrastructure that they had and raise the level of innovation, Newfoundland had to move quickly to build new infrastructure that would be an economic engine that could steer the economy away from its dependence on the ground fishery.
* ACOA has supported the development of centres that build upon the underlying sectors of the economy and the existing research capabilities of the province. In particular there has been a close relationship with Memorial University and its capabilities in pure and applied sciences and on the oceans and related disciplines.

3.1.4 Prince Edward Island Region

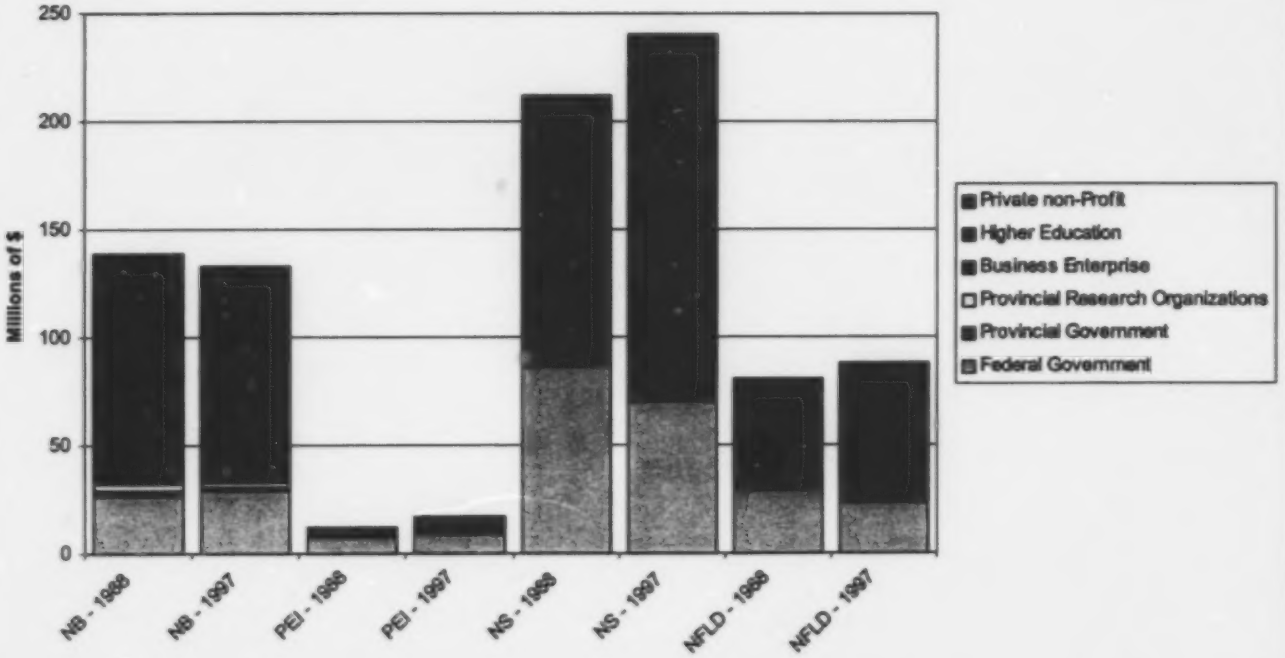
* ACOA worked very closely with the few key players that are on the Island. UPEI, the Atlantic Veterinary College and the Food Technology Centre all became involved in efforts to stimulate innovation.
* PEI's economic base is more restricted than is evident in any of the other Atlantic Provinces. Consequently, the breadth of support was narrower primarily focused on food process, fishing and aquaculture.
* ACOA's strategy was to utilize the research capacity on the Island to create new opportunities for existing or new ventures.

3.2 R&D Around the Region

Exhibit 11 shows the provincial GERD for 1988 and 1997 by each performing sector.

* Total GERD has grown marginally in PEI, Nova Scotia and Newfoundland. Total GERD in New Brunswick has decreased during this time.
* In New Brunswick, Higher Education and Federal Government Sectors grew while Business Enterprise sector declined sharply.
* In Newfoundland, Higher Education and Business Enterprise sector grew while Federal Government declined.
* In Nova Scotia, Higher Education grew sharply while Business Enterprise sector and Federal Government declined.
* In PEI, Business Enterprise sector grew while Federal Government declined.
* R&D in the Higher Education Sector in all the Atlantic Provinces was the fastest growing sector between 1988 and 1997. The major funding contributor to this growth was the Higher Education Sector itself. **Exhibits 1 and 2** and **Table 2** describe this in greater detail. They also show that from 1988 to 1997 funding by the Federal Government grew by 8.7% in Atlantic Canada versus 26.7% for the rest of Canada.

Exhibit 11: Provincial GERD 1988 vs 1997 (Millions of Dollars) by Performing Sector



Source: *Estimates of Canadian Research and Development Expenditures (GERD), Canada 1988 to 1999, and by Province, 1988 to 1997,* Statistics Canada, Catalogue no. 88F0006XIB-99008

* By contrast to the Atlantic Region's rate of growth in the funding of Higher Education, R&D by the Business Enterprise sector, Provincial Government and Private non-profit sectors has lagged the nation.
* From 1988 to 1997, nationally, R&D performed by Business Enterprise sector doubled. In the region, it declined close to 20%.

3.2.1 Higher Education Sector

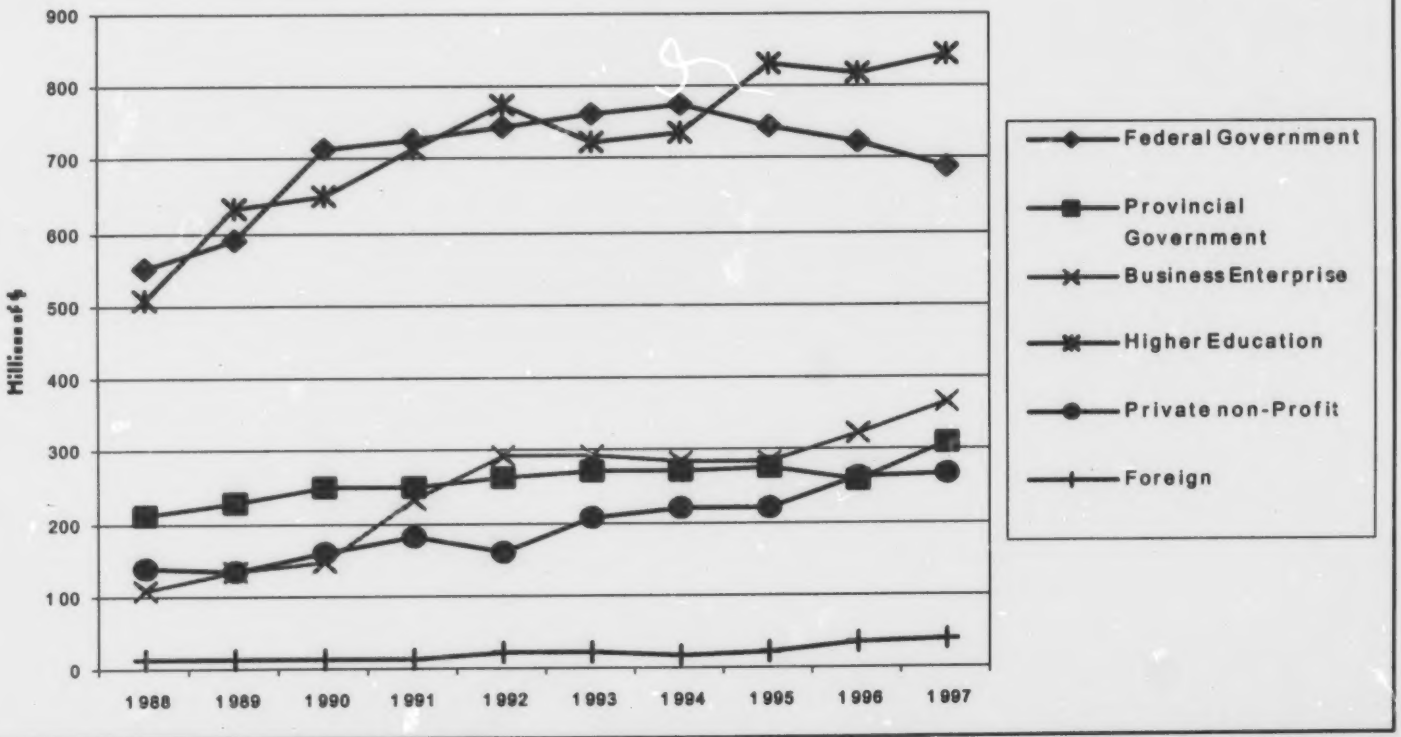
Exhibits 12 and 13 show the source of funding between 1988-1997 for Natural Sciences and Engineering in the Higher Education sector for Canada and the Atlantic Provinces, respectively.

* ACOA's support for Higher Education Sector has helped to increase their level of performance. Through both operating and capital funding, ACOA has supported the Higher Education sector.
* More recently, according to university key informants, without ACOA's support of Higher Education, CFI funding would have been dramatically lower than the $13.1 million it will receive.
* The level of R&D performed by the higher education sector was not negatively affected by the recession of the early 1990's.
* Nationally the contribution made by the Higher Education sector to its research has grown by about 65%, in this region the growth is closer to 90%. This suggests that the use of in-kind contributions by the Higher Education sector has played an important role in keeping R&D activity levels up.
* Funding from the Federal Government for R&D has shown a similar pattern in Atlantic Canada as in all of Canada. While Federal expenditures increased up to the early 90's they were subsequently reduced in 1995 to 1997. In Atlantic Canada, the reductions began sooner in 1993 and leveled off in 1995. As well, the region experienced a sharper drop in expenditure levels.

* Nationally, Business Enterprise sector's contribution to the Higher Education sector grew by 244% between 1988 and 1997. In Atlantic Canada the figure is 133%.

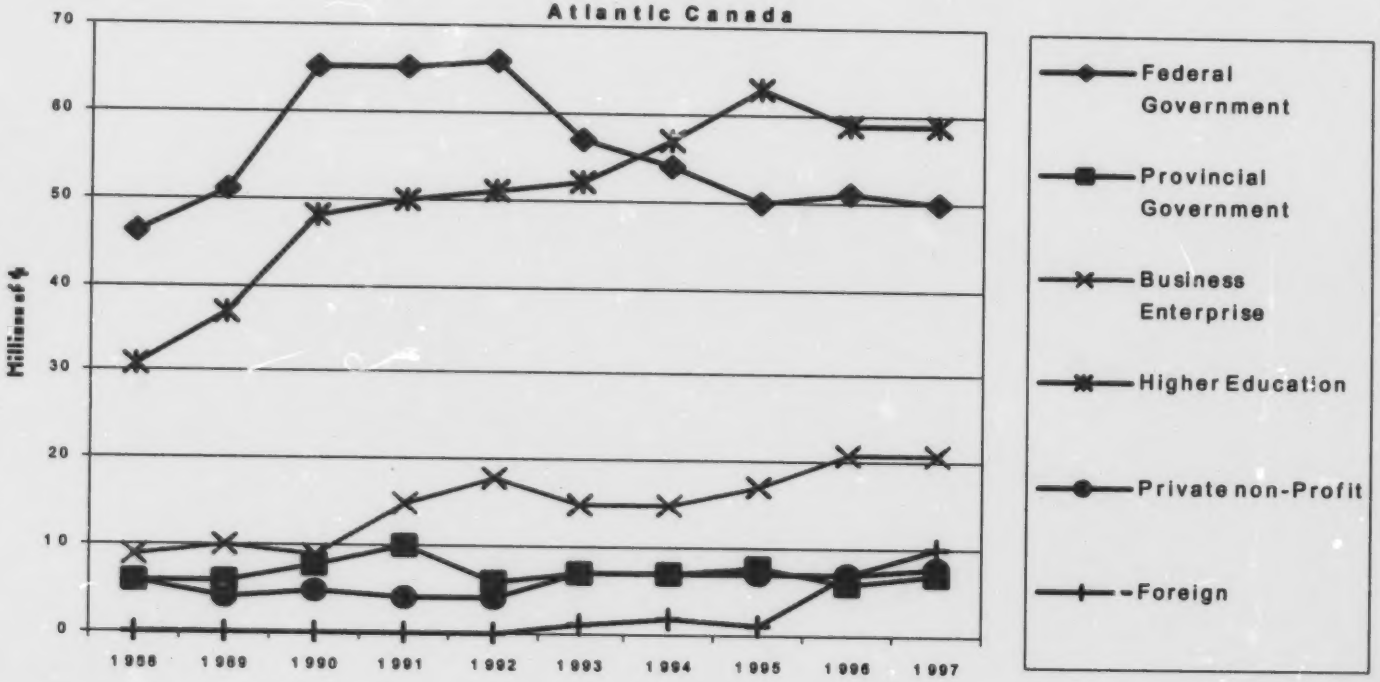
Exhibit 12: Source of Funding for Natural Sciences and Engineering (1988-1997)- Higher Education

Canada



Source: ***Estimates of Canadian Research and Development Expenditures (GERD), Canada 1988 to 1999, and by Province, 1988 to 1997,*** **Statistics Canada, Catalogue no. 88F0006XIB-99008**

Exhibit 13: Source of Funding for Natural Sciences and Engineering
(1988-1997)
Higher Education
Atlantic Canada



Source: ***Estimates of Canadian Research and Development Expenditures (GERD), Canada 1988 to 1999, and by Province, 1988 to 1997,*** **Statistics Canada, Catalogue no. 88F0006XIB-99008**

* One funding source that has grown faster in Atlantic Canada than in Canada is the Foreign sector. Between 1995 and 1997, funding from this sector doubled for all of Canada. In Atlantic Canada this funding experienced a 10 times increase from $ 1 million to $10 million.

3.2.2 Business Enterprise sector

Exhibits 14 and 15 show the source of funding, between 1988-1997 for the Business Enterprise sector for Canada and the Atlantic Provinces respectively.

* In Atlantic Canada, the Business Enterprise sector performed less R&D in 1997 than in 1988.

* While expenditures for 1988 and 1997 show a small difference, there was a much more significant change during this period of time. Business Enterprise sector declined from nearly $100 million in 1989 to nearly $40 million in 1991. Since 1991 expenditures have steadily grown such that in 1997 they exceeded 1989 levels.

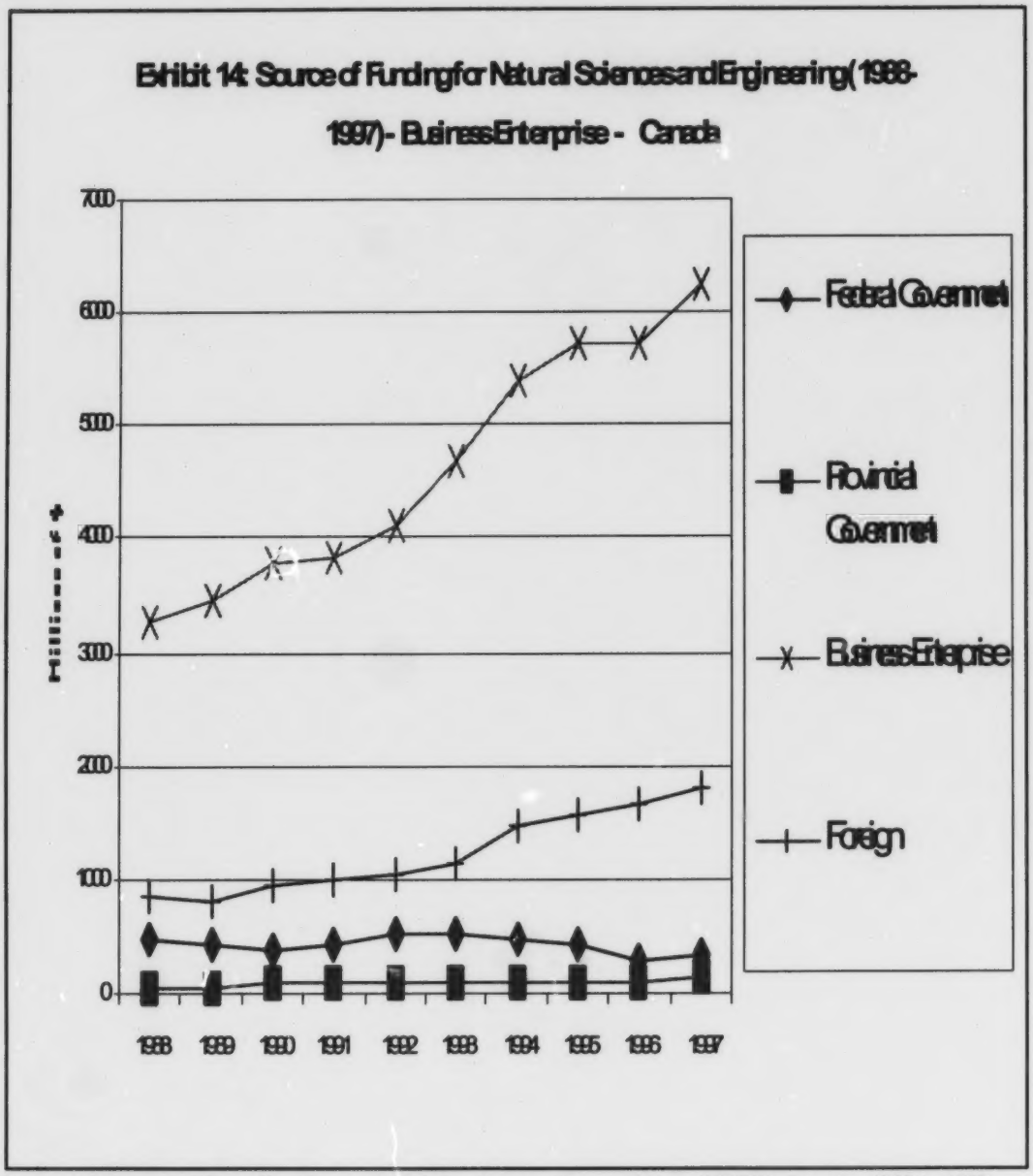
* There is a significant variance in the funding trends experienced in the Business Enterprise sector between Canada and Atlantic Canada. While in Canada the period 1988 to 1997 was a period of essentially consistent growth, in Atlantic Canada the situation was more tumultuous.

* Coinciding with a drop in Federal Government funding and the 1990's recession was a significant drop in Atlantic Canada in R&D funded by Business Enterprise sector.

* Nationally, during the period 1988 to 1997, R&D performed by the Business Enterprise sector has doubled. In Atlantic Canada during this same time period, R&D performed by the Business Enterprise sector has declined 11.4%, going from $149 million to $132 million. This poor performance compared to the country's performance (which in 1996 ranked only 6th out of the G7 nations) will make it harder for the region to be competitive.

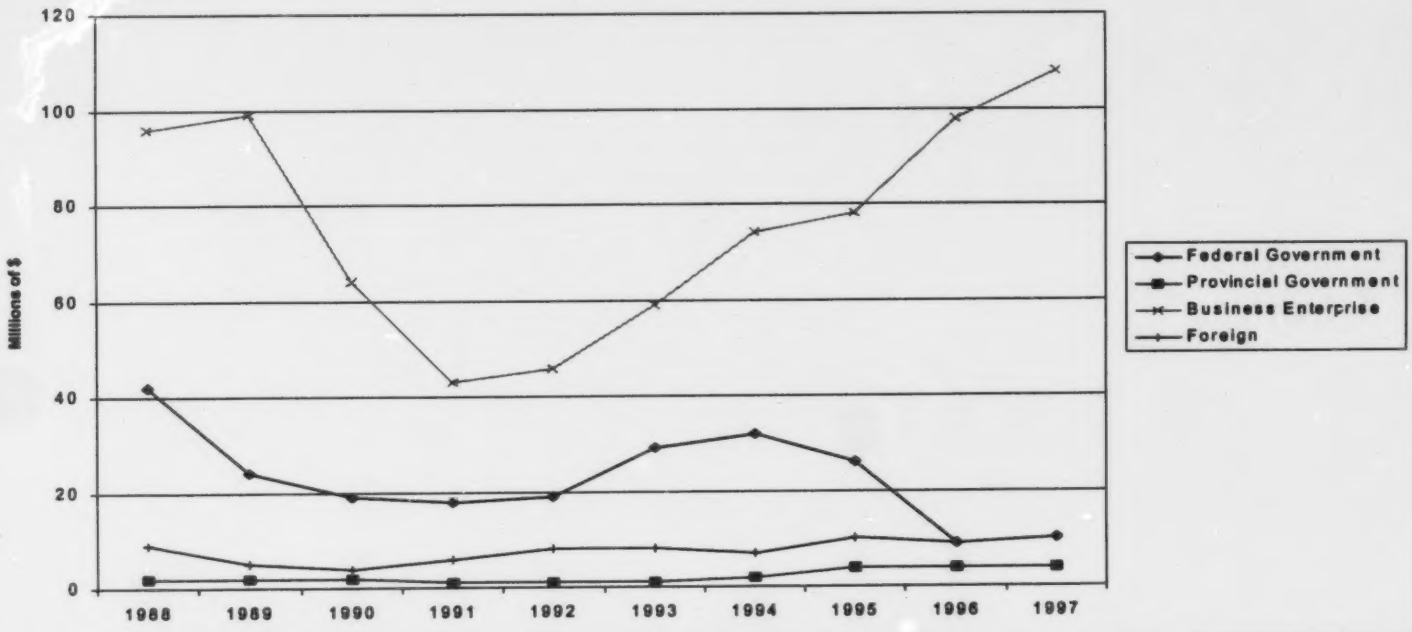
* From 1991 to 1997, R&D conducted by this sector was increasingly funded from within the sector through cash flow, investment and debt.

Applied Management



Source: Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1988 to 1999, and by Province, 1988 to 1997, Statistics Canada, Catalogue no. 88F0006XIB-99008

Exhibit 15: Source of Funding for Natural Sciences and Engineering (1988-1997)- Business Enterprise Atlantic Canada



Source: Estimates of Canadian Research and Development Expenditures (GERD), Canada, 1988 to 1999, and by Province, 1988 to 1997, Statistics Canada, Catalogue no. 88F0006XIB-99008

3.3 Productivity GDP and Trade

Exhibit 16 and **Table 11** show total factor productivity indices for Canada and each of the Atlantic Provinces, and exports as a percentage of GDP, respectively.

* Total Factor Productivity (all industries) for Canada is higher than for each of the Atlantic Provinces.

* Similarly, GDP growth for Canada has exceeded the region.

* Innovation and Productivity are vital to exports. These are keys to the region's future success.

* Generally, where Productivity is competitive, GDP growth and trade growth are closely linked.

    * For example:
        - Manufacturing in PEI and NB
        - Fishing in Newfoundland, Aquaculture in NB
        - Business Services around the region
        - Communication industries around the region

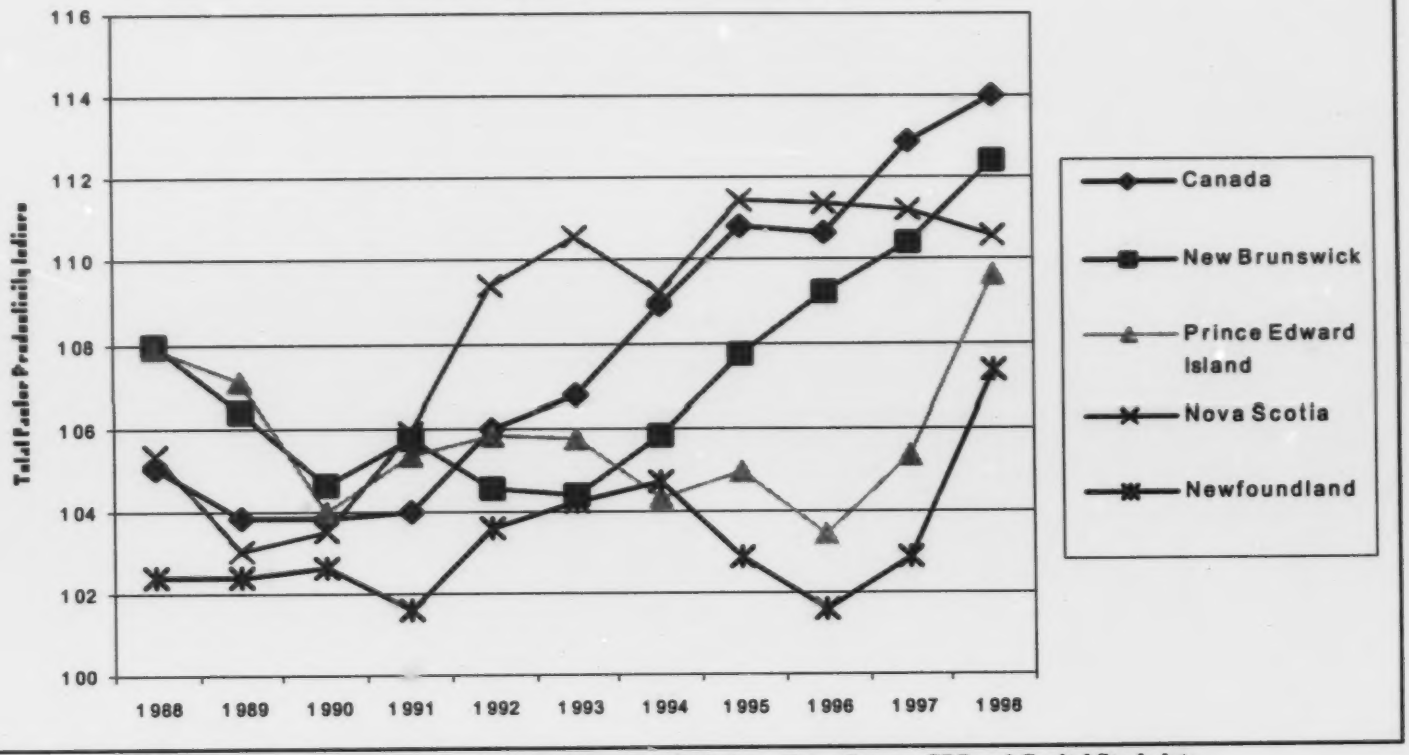
* ACOA has supported innovation and technology initiatives that are closely tied to these improvements.

* Data produced by The *Centre for Study of Living Standards* speaks most eloquently about the recent rejuvenation of the Newfoundland fishing industry: Value-added per worker employed in the fishing and trapping industries went from $6,603 in 1994 (constant 1992$) to $14,761 in 1998, a phenomenal increase of 123.5%. By comparison, this measure increased from $15,310 to $18,887 for the whole of Atlantic Canada over the same period, an increase of 23.4%, and from $21,253 to 23,926, an increase of 12.6% for Canada.

* By all indications, CCFI with its emphasis on innovation and the partnering of academic

research and development capability and expertise with private sector needs, has played a key role in this major reversal.

Exhibit 16: Total Factor Productivity Indices Canada and Each of the Atlantic Provinces 1988-1998
All Industries
Using Number of Hours Worked (1984=100)



Source: Centre for the Study of Living Standards, based on Statistics Canada Labour Force Survey, GDP and Capital Stock data

TABLE 11: Exports as a Percentage of GDP

	1984 (%)	1990 (%)	1996 (%)
Canada	27.5%	24.1%	36.7%
New Brunswick	30.7%	26.9%	35.4%
Prince Edward Island	14.6%	13.2%	16.7%
Nova Scotia	17.7%	15.7%	19.4%
Newfoundland	28.7%	29.2%	30.1%

4 Challenges and Lessons Learned

The evaluation review, through key informant interviews and the survey of centres, sought to identify the particular challenges facing centres that support innovation in Atlantic Canada as well as any lessons that have been learned. This section presents these challenges and the lessons learned.

Appendix E presents a summary table of the centres. It contains the challenges and lessons identified by each centre.

4.1 Challenges to Commercialization

4.1.1 Lack of Receptors to Commercialize Intellectual Property (IP)

* By and large, Atlantic Canada lacks a strong industrial base of companies that can commercialize intellectual property and be receptors. Typically, good receptors are companies that are well capitalized such that they can afford to invest the necessary funds for additional R&D, prototype development, and patenting. Ideally these companies have established channels of distribution and corporate infrastructure to support the major business functions such as financial control and marketing.

* In Atlantic Canada, typically these receptor companies are start-ups. As such they require financing which is not widely available and people who are skilled in making a successful start-up. These skills are not common in Atlantic Canada.

* The industrial base in the region is more suited to application expertise re: improvement, productivity etc. than to supporting start-up ventures.

4.1.2 Pool of Talented Entrepreneurs Remains Small but is Growing

* Increasingly the region is supporting start-up companies. In some cases this is with local talent, in other cases this is with talented entrepreneurs who have relocated to the region.

The pool of talent in the region remains small but it has grown and will continue to grow. The limited talent pool has made it more difficult to get good partners and to stimulate economic success.

4.1.3 Commercialization is a Costly Process

* Commercialization is a costly process that requires significant risk capital. With a lack of exisiting receptor companies two alternatives remain; licensing or start-up ventures. The universities in the region do not have the internal resources to finance start-up companies. Nor do they have the management experience to successfully deal with managing and running start-up companies. Seabright in Newfoundland, began with the concept of spinning off start-up companies. Quickly, the organization was getting buried by the burden of managing and financing a wide array of start-up companies. Now, Seabright licenses the technology to local entrepreneurs who want to partner with the university. While Seabright does everything that it can to support these companies it does not take on the responsibility of running or financing the company. In this way, Seabright can focus its efforts on what it does best, recognizing valuable intellectual property and finding partners who can commercialize it.

4.1.4 Protecting IP is a Costly Process

* Universities across the country have recognized that the cost of protecting IP is high. In order to protect their IP, universities must bear the costs associated with patenting and copyright protection, the costs of identifying whether other groups are inappropriately infringing on their IP and the legal costs of enforcing their IP rights.

  This is an expensive proposition. While large universities can afford such overhead, small universities cannot. The Federal Science and Technology Strategy proposes directing a portion of research funding toward commercialization activities. While this makes imminent sense for larger universities with big research budgets, it will not be feasible for many small to medium size universities such as in Atlantic Canada. It has been suggested by some key informants that the region requires a Pan-Atlantic initiative to make commercialization feasible.

4.1.5 R&D is Not a High Priority for the Provincial Governments in the Region

* Several Canadian provinces, namely Ontario, Quebec, Alberta and Manitoba, have provincial government programs that financially support companies willing to invest in R&D. These jurisdictions have recognized that this type of support is an inducement to investment. The Atlantic Provinces do not offer a competitive matching program. Apparent budgetary pressures have made the region's provincial governments focus on education and healthcare as their highest priorities.

4.2 Challenges to Self-Sufficiency

4.2.1 Policy Conflict - Self-sufficiency vs. Economic Development

* Many survey respondents and some key informants indicated that there is a major policy conflict. The conflict relates to the requirement that centres supporting innovation achieve self-sufficiency and the economic development objective to transfer the fruits of their research to regional SMEs. Self-sufficiency can best be achieved by licensing or selling technology to large multinational firms. Given the shortage of "receptor" companies in the region, there is a great deal of time and effort required to nurture the creation and expansion of local firms. As one key informant noted, "it is easy to start them (firms), it is feeding them which is extremely difficult".

* Nurturing local receptors is not an activity for which research centres are typically funded. Consequently, there is a real cost to these centres when they work in the interest of economic development.

  The September 1999 report *"A Review of the Telecom Applications Research Alliance (TARA)"* noted that the mentoring services provided by TARA were particularly appropriate to growing and strengthening the centres' clients. In fact, of the report's five recommendations, one was specifically focussed on strengthening their mentoring functions.

  Similarly the Genesis Centre has been lauded for its mentor program.

  These types of services and matching are important elements to I&T success. They are also costly for centres to provide since typically they must be provided at little or no charge.

4.2.2 Repayability has Significantly Dampened Activity and Revenues

* Several centres have indicated that repayability, even on a provisional basis, has had a major dampening effect on the R&D activity of small firms and consequently on the revenues of research groups. Changes to ACOA's repayability policy is closely related to a sharp decline in R&D expenditures in the Business Enterprise sector, as can be observed in **Exhibit 13** in Section 3.2.2. Entrepreneurs generally feel the risk associated with such investments are too high and too demanding on their limited management resources. ACOA's rules are deemed to be more restrictive than IRAP funding in this regard. From the perspective of venture capitalists, contingent royalty payments are viewed as a drain on a company's financial viability, make a company less attractive and thus reduce its ability to attract external equity financing. Finally, the reduced activity of SMEs is having a direct and immediate impact on the operations of R&D centres in the region, particularly contract research organizations.

4.2.3 International Focus of Centres Increasing

* One indirect consequence of placing self-sufficiency at the core of supporting R&D centres in the region is that increasingly these centres are required to seek international markets for their services. In one instance, one centre had to adopt a major shift in its mission statement from a "service orientation" geared to supporting local SMEs to a "wealth creation orientation" leading to a policy which allows its scientists to take a direct equity participation in the fruits of their research. Also, the "push" to international marketing is prompted by the desire not to be seen with competing with other R&D centres in other provinces that have also received ACOA funding.

* Many of the centres participating in this study indicated that the pressure to be self-sufficient is forcing them to seek international partners for research and for commericialization of IP. There are several dangers associated with this situation:

    - Economic benefits of Canadian IP may accrue to foreign jurisdictions.
    - Canadian and American patents do not apply to Europe or Japan, consequently piracy can be an important concern.

- Universities, especially Atlantic Canadian universities because of their smaller size, cannot afford to properly protect IP, thus making them more vulnerable to piracy.

* Increased funding levels from foreign sources (reported by Statistics Canada) suggest that this is a reality and not merely a negotiating tactic.

4.2.4 Developing to Hit a Moving Target

* Development of new products is a costly and time-sensitive process. For groups involved with contract research this poses particular challenges. Through the process of development new options and directions for development can be identified. This creates a "Catch 22" situation. If these new options or directions are not incorporated the product may be obsolete once it is complete. Alternatively, the private sector sponsor will often have run out of money before the product is completed. To minimize these situations groups like Concept+ have instituted an extensive process of advance review. The challenge to self-sufficiency comes in that this is a time consuming process for which it is not possible to recoup the costs.

4.2.5 Limited Capabilities of Private Partners - Management and Financial

* Many of the private partners that are in the region have limited capabilities to manage their businesses and to develop new markets. In addition many of these partners have limited resources to allow for contingencies in the development of commercialization process. This makes licensing arrangements precarious at best.

4.2.6 Time-frames Too Short

* The time frames that applicants (centres and universities) put in their plans are considered to be too short to reasonably develop self-sufficiency. Several centres indicated that they felt pressured to make unrealistic promises about the time frames for impact and self-

sufficiency. Developing long term relationships with private sector organizations takes a long time and requires long term stability.

4.2.7 Generating Enough Revenues to Allow for Replacement of Obsolete Equipment and to Evolve Services

* The needs of industry change over time. For centres to remain useful, they must replace obsolete equipment and bring on new infrastructure. Consequently, the role and capabilities of the centres must evolve. Centres in this region have a difficult time generating sufficient revenues to contribute toward capital replacement based on standard depreciation schedules. To be able to evolve and change what a centre does would require the generating revenues sufficient to accelerate the depreciation schedule.

4.3 Lessons Learned

4.3.1 Non-commercial Centres Need to Keep Better Account of the Status of Their Clients

* Non-commercial centres need to keep better account of the status of their clients. Through this evaluation, it was clear that many centres do not keep good records on the impact of their operations. As a consequence, some centres were unable to demonstrate economic impacts. Not only is this information useful for evaluation purposes and to justify investments, but also it is critical to selling services.

4.3.2 IP Management is Critical

* IP management in universities is critical and has not received adequate attention; properly managed it can be a strong contributor to the economy.

* Proper management and protection of intellectual property is essential to maximize the value of this asset. With the exclusion of Seabright, IP technology transfer has been largely ignored. IP like other assets needs to be managed, protected and developed. When IP commercialization is done well it can be a strong generator of regional economic benefits. However when it is mismanaged, as one centre reported, it can be pirated and the benefits will accrue to other regions of the world.

4.3.3 Too Little Attention to the Business Feasibility Issues

* Many centres indicated that they are recognizing the importance of dealing not only with the technological issues but also with management and business feasibility issues. The speed at which technology is changing means that centres have to quickly find suitable private partner's in the case of IP commercialization, and that contract research has to work in a closer relationship with market development.

- As one centre's director stated, the success of new technologies or products is one half technology/product with the other two halves being marketing. (This is not meant as a mathematical truism but as a reality of the innovation cycle.) Centres have learned the hard way about the importance of marketing. The best product in the world will not sell itself. When selecting partners for commercialization close consideration of the management and marketing capabilities is essential. This is not an area where university research groups have much experience.

- Research centres have learned that marketing and management expertise in their clients is integral to the ultimate impact of their work.

- Consequently, some centres have implemented mentoring and business support services while others prescreen clients to eliminate those that are less likely to succeed.

- Some centres indicate that SMEs have sufficiently limited financial resources that they cannot afford to properly structure their development and fund any contingencies. Consequently, the centres have been left with cost overruns that cannot be recouped.

4.3.4 Critical Mass is Essential to Self-Sufficiency and Appropriate Function

- The scale of operations for some centres was inadequate to make the operation self-sufficient. One centre noted that in order to strive to be self-sufficient, they had taken on some projects that were beyond their capabilities and contracted to complete research for which they were not well qualified. As a consequence, the project was a failure. The objective of self-sufficiency must be well planned such that the centre can develop a critical mass upon which it can build.

- With sufficient critical mass, centres can develop strategic alliances with other centres to offer a broader range services. Not only will this provide better value to SMEs it will reduce failures, reduce duplication and improve linkages.

- One centre that does not have a full-time director stressed the importance of a centre having sufficient critical mass to have a full-time director. Without this commitment the centre noted they could not maintain its mass.

* Overlap and competition with the private sector must be specifically avoided. Centres need to clearly define a "niche" that does not compete with the private sector in the area served. Competition with the private sector led In*NOVA*corp to dismantle and sell off much of its "bricks and mortar" research capacity

4.4 Lessons Learned - Best Practices

Best practices are vital to long-term viability, success and economic impact of the region's research centres. The Best Practices Case Study contained in **Appendix G** includes a full analysis of best practices at some of the region's centres. A discussion of the findings is next.

4.4.1 Finding Capable Private Partners

* Seabright's first approach is to seek a private partner for technology licensing. This reduces the cost and burden on Seabright that is typically related to spin-off companies.

* Where capable private partners need to be developed, Seabright uses Operation MENTOR and has established the GENESIS centre. This centre supports the development of local partners by being an incubator as well as by playing a key role in matching companies to mentors and investors. The MENTOR Program provides highly qualified mentors for companies. The mentors are largely Newfoundlanders, who in most cases, have out-migrated from the province - people like John Kelly, President of Jetforms Inc. in Ottawa and Darryl Fry of Cytech in New Jersey - and have launched their own successful high growth technology based enterprises.

* TARA also has been effective in using mentoring to develop more capable private partners.

4.4.2 Be Proactive About Finding Valuable IP

* Most significant is the fact that the staff of Seabright are very proactive in their search for IP that has potential value. Memorial maintains ownership of the IP created by its staff by virtue of the collective agreement with its faculty. This allows Seabright the flexibility to discover more about the IP that researchers have. In some other models, for instance NUTECH, the onus is on the researcher to seek to commercialize IP. Memorial's IP ownership arrangement gives Seabright a distinct advantage in its ability to find value and commercialize it sooner.

4.4.3 Screening Out Poor Projects and Poor Partners

* The Economic Assessment of Seabright Corporation completed by Thomas Clift of the University of Western Ontario noted that Seabright's patenting activity was only half of the average for Canadian universities. The report goes on further to say "but on a relative basis, its' (Seabright) licensing activities compare favourably to both Canada and the US".

* In order to screen out poor projects, Seabright undertakes a rigorous assessment of technical and commercial viability of patentable and licensable innovations. Innovations that are considered viable receive additional effort. For example, the patent process is only sought for innovations that pass the assessment process.

* As a first step, Concept+ completes an extensive review of the technical and commercial viability of a potential development. The centre has learned through experience the importance of narrowing down the possible projects in which it participates. As an example, dealing with "inventors" accounts for roughly 1/3 of the employees' time. These clients need intensive hand-holding and advice, requiring on average about 40 hours without any revenues generated for the centre, which considers this category of clients part of its "public" mandate. The risk is high (only 5% ever reach viability), however, returns can also be extremely high, viz., Spielo. During its recent planning exercise, Concept+ Inc. estimated that as a result of performing this function over the years, it had invested about $1.6 million in non-recoverable costs (1 person-year @ $84/hr. times 20 hours per week times 16 years).

4.4.4 Focus Not Only on Technical Issues But Also on Business Issues

* In*NOVA*corp has mapped the full cycle of support for innovation from bench research to commericialization. In*NOVA*corp is focussed on supporting the commercialization of technology. Their aim is to help companies grow, compete and export by helping to improve: **Business skills:** the management, marketing, or financial skills of the entrepreneur and **Technology:** enhancing the quality, productivity, efficiency or process of a product or service. In particular, the group now offers the following services:

- Equity Investment
- Business Incubation
- Information Services
- R&D support (through IRAP)
- Technology and Quality Solutions
- Product design and process development

* This package of services recognizes the important role that business issues play in the commercialization process. By bringing together this package of services, entrepreneurs will be better served. Their needs will no longer be considered only technical until the product is developed.

4.4.5 Develop Means of Supporting Business Issues: Venture Capital Links, Mentors, etc.

* Seabright goes well beyond the potentially narrow role of a Technology Licensing Office. For the purpose of economic development, Seabright maintains relationships with venture capitalists and is constantly expanding its network of contacts to identify potential mentors for technology companies. These activities have raised millions of dollars of venture capital and made connections between young start-up companies and established business people. Through this network Seabright supports the development of not only its spin-off companies but also the companies in the Genesis Centre.

4.4.6 Focus on Particular Strengths and Abandon Unsuccessful Areas

* Concept+ has recognized its need to focus on its particular strengths and to abandon markets and services which were not successful. This process of evolution is a key element to the long-term success of a centre and to the responsiveness of the centre to the needs of the local economy.

* The recently completed strategic planning exercise undertaken by Concept+ Inc. concluded that there are two fundamental and primary market niches where it has a competitive advantage and where it should focus its efforts. It has determined that there

is a core group of client companies located in the region, many of whom have had to go outside to source these services.

4.4.7 Bring Together Partners to Strengthen the Chance for Success

* In*NOVA*corp is bringing together partners from around the region to strengthen the chance of success. The Life Sciences Industry Partnership includes amongst others BioAtlantech from New Brunswick and Seabright from Newfoundland. This combination demonstrates a clear indication of the trend toward cooperation versus competition.

* In*NOVA*corp in conjunction with partners from around the region are collaborating to expand the life sciences industry (through the Life Sciences Industry Partnership - LSIP) and to continue the excellent growth in IT that the province and region has experienced.

4.4.8 Act as a Catalyst or Prism (Linking University Expertise and Private Sector Needs)

* While not specifically part of the best practices case study, CCFI demonstrated a key best practice activity by acting as a catalyst.

* There are several quotes contained in the Baird/Andrews report underscoring the extent to which there is a high degree of unanimity that CCFI has been the main catalyst behind the major improvement over the past decade in the relevance of the University to the fishing industry. These quotes are worth repeating here:

    * From the industry:
      The fishing industry does not have traditional linkages with universities. Individual companies cannot afford staff to liaise directly with the University and the Marine Institute. CCFI provides this vital linkage. This is its most important role.

    * From the government:

The University had a lot of expertise that the fishing industry did not know how to access. CCFI has become the all important link and has allowed industry to tap into the scientific expertise of the University and Marine Institute. Today there is a lot more applied fisheries research at MUN than before CCFI.

* From MUN/MI:
CCFI has played a vital role in bringing us together with industrial partners. Without CCFI, we would not be relevant to the fishing industry's needs.

If CCFI was not here, the Ocean Sciences Centre would not be here. Cold water aquaculture would not have gotten off the ground to the extent that it has. CCFI has been the driver in increasing the interaction of MUN and the industry.

CCFI has changed the outlook of many University faculty to look at species that are economically viable versus what is scientifically interesting.

5 SWOTS Analysis and Strategic Issues for I&T in the Region

This section of the report discusses the strengths, weaknesses, opportunities and threats related to I&T in the region. The section also discusses the strategic issues emanating from the evaluation's findings.

5.1 Strengths

The following are considered to be the region's strengths:

* Aquaculture sector – the past growth and anticipated growth of this industry make it a vital strength of the region.

* IT and communication skills – the region has developed considerable skills both corporate and human resources related to IT and communication.

* Productive and growing communications industry – the communications industry in the region is very competitive with strong growth and good productivity.

* Business Services Growth – the growth experienced by the region in business services is a significant success story and a strength upon which to build.

* Research capacity – the presence of certain key components of the region's research infrastructure is a strength upon which to build. In particular, the region contains two medical schools and the Atlantic Veterinary College. These facilities combine with the regions engineering, communication and scientific strengths.

* Seabright model – represents a success story in the licensing of technologies. The presence of this model in the region is a strength for the region.

* Private sector/University cooperation – there have been some good examples of cooperation between these two sectors:

- (Cadmi U de M) later Concept+ and Spielo Industries
- Canadian Centre for Fisheries Innovation and Fisheries Products International
- Atlantic Veterinary College and the New Brunswick Aquaculture industry.

* Volume of graduates with technical backgrounds – is high in relation to other parts of Canada. This creates a good supply of skilled technical resources who can increase the I&T capability of companies and who can support growth.

5.2 Weaknesses

* Limited Expertise in IP Management – Universities generally have limited expertise in managing, protecting and transferring IP.

* Few Middlemen – There are few who are working in between the universities and industry. Their role is to source university skills to solve private sector problems or create opportunities for commercialization.

* Lack of priority for I & T with provinces. Provincial funding and commitment for I & T has been limited.

* Lack of Risk Capital – The region lacks risk capital that can bridge a firm between their use of informal investors (love money and angels) and structured Venture Capital. This money needs to be high risk capital.

* Receptor Capacity – The regions industrial base is not ideally suited to being a receptor for commercializing university IP.

* Declining Private R & D – According to Statistics Canada expenditure on R & D in the Business Enterprise Sector has declined in Atlantic Canada.

* Repayability Policy – ACOA's repayability policy has dampened private investment in R & D and has reduced revenue of contract research groups.

* Self-sufficiency – The drive for self-sufficiency does not fully reflect the role centers play in economic development and the costs of this role.

* Lack of Management Depth and Experience – SMEs are lacking experience in successfully building start-up technology companies.

* Lack of Harmonization – Provincial competition rather than collaboration among the Atlantic Provinces; for example, numerous food research centres across the region.

* ACOA's timing and responsiveness – to applications from centers. Long turn-around time in some instance leads to instability in these centers.

5.3 Opportunities

* Expanding growth industries – to continue to expand upon the growth experienced in Aquaculture, information technology, communication and business services.

* Transfer technologies from universities and federal research facilities – Growing R & D activity in universities has created good potential for technology transfer. E.g., one of the region's universities has more than 30 technologies ready for transfer.

* CRO Capability – the region has some contract research organizations that have demonstrated their ability to deliver tangible impacts.

* Potential NRC Centres of Excellence – offer the potential to increase technology transfer.

* E-Commerce Proliferation – with the growth of e-commerce there is an opportunity to help proliferate this as an enabling technology.

* Marine Expertise and nature of region – creates opportunities to focus on related I & T initiatives.

* Medical Schools/AVC – the presence of two medical schools and the Veterinary School represent good opportunities for life science spin-offs.

5.4 Threats

* Shrinking University Activity - Universities have been a highlight in the region's R & D activity, however, should this sector experience diminished support, than the high levels of activity could be curtailed.

* Export of IP – increasing amounts of foreign funding for R&D in the region's centers increase the likelihood that IP will be exported or pirated.

* Outdated I&T Capability – Centres which are unable to generate sufficient revenues will see their infrastructure become outdated.

* Brain drain – diminished regional opportunities will accelerate a brain drain not just for young graduates but also for experienced researchers. Unlike other parts of Canada, Atlantic Canada does not attract immigrants who can replace this talent.

* Obstacles to growth – Can arise unexpectantly. The ability of researchers and producers to be able to respond effectively can be paramount to success. E.g., further expansion of the Aquaculture industry requires research into alternative species and production techniques. Without this research growth would be limited.

5.5 Recommendations

This section describes the recommendations that ACOA should consider to strengthen efforts in I&T. The recommendations have been grouped into four categories.

Table 12 is a strategic issues matrix that summarizes the strengths, weaknesses, opportunities, threats and recommendations.

5.5.1 Skills Related Recommendations

These are recommendations related to improving the management skills of companies.

* Increase Mentoring – The Genesis Centre and TARA have both been recognized for the mentoring activities they promote and the impact these are having. ACOA should support efforts to develop effective mentoring programs of nature similar to the Genesis Centre. The funding by ACOA of mentoring activities performed by the research centres would help to offset costs incurred for regional economic development activities.

* TPI type initiative for new graduates – to feed the growth in the region it is essential that the demand for technical skills be satisfied. With the volume of suitable graduates

coming out of Atlantic Universities and the brain drain experienced by the emigration of these graduates it is apparent that there is a need to stem the tide.

TABLE 12: Strategic Issues Matrix

	Opportunities 1. Expanding growth industries 2. Tech. Transfer from Univ. 3. CRO capability 4. Potential NRC centres of excellence 5. E-commerce proliferation 6. Marine expertise and nature of region 7. Medical schools/AVC	**Threats** 1. Shrinking Univ. activity 2. Export of IP 3. Outdated I&T capability 4. Brain drain 5. Obstacles to growth
Strengths 1. Aquaculture sector 2. IT and communication skills 3. Productivity and growing communications industry 4. Business Services growth 5. Research capacity 6. Seabright model 7. Private sector/university cooperation 8. Volume of graduates with technical backgrounds	**Recommendations** 1. Replicate Seabright 2. Continue aquaculture support 3. Biotechnology/life sciences 4. TPI type initiative for new graduates 5. IT & communication initiatives 6. Parellel to NRC centres	**Recommendations** 1. TPI type initiatives for new graduates

Weaknesses	**Recommendations**	**Recommendations**
1. Limited expertise in IP management 2. Few middlemen 3. Lack of priority for I&T with provinces 4. Lack of risk capital 5. Receptor capacity 6. Declining private R&D 7. Repayability policy 8. Self-sufficiency 9. Lack of management depth and experience 10. Lack of harmonization 11. ACOA's timing and responsiveness	1. Bridging support 2. Prism/brokers 3. Raise profile with venture capital community 4. Increase mentoring 5. Encourage a culture shift in universities 6. Improve mentoring of clients	1. Conditional licensing 2. Repayable investment fund for centres

This initiative would encourage local companies to hire new graduates by supplementing their income for a period of time. ACOA could also complement other programs from groups such as HRDC to extend the duration of support. This is particularly important for highly technical fields.

5.5.2 Funding Related Recommendations

These are recommendations related to improving the funding situation for companies and for the research centres.

* Raise profile with Venture Capital Community – Venture Capital investing is at an all-time high. The region does not appear to be benefitting to a large extent from this boom in Venture Capital. ACOA should consider efforts to raise the profile of the region amongst the Venture Capital Community to stimulate investment.

* Repayable Investment Fund for Centres – ACOA should investigate providing research centers with a conditionally repayable investment fund similar to what TARA has. This fund would allow centers to make strategic investments in technology companies, thus mitigating the lack of risk capital. The investment portfolio could help fund both future investments in companies and may allow centers to invest residual proceeds into their own capabilities. By building an investment portfolio, the centres could participate in the success of their clients and others in who they had invested. The funds would be conditionally repayable by the centre. This would mean they would only repay those investments that were successful. One specific area of investment that these funds could address is the provision of high risk capital to firms for prototype development. Generally, these firms are not yet ready for venture capital.

5.5.3 Strategic Sectors/Clusters Recommendations

These are recommendations related to various strategic sectors or clusters.

* Continue Aquaculture Support – The Aquaculture has the potential to further multiply its size and economic impact. The effective support within the research community provided through Huntsman Marine, AVC, RPC, CCFI and others should receive continued support.

* Biotechnology/Life Sciences – the growth that has been experienced and the potential for future growth are excellent for these industries. The region's medical schools and AVC offer good potential for future successes. Recent growth in this sector should help to attract attention and Venture Capital. Many of the elements for success appear to be coming into place. Sustained effort is now essential.

* IT and Communication initiatives – should also be a future focus. By leveraging the region's skill base and the industrial base it should be possible to develop initiatives in this important sector.

* Ocean/Marine Sciences - the ocean and marine sciences sector represents excellent opportunities for continued growth. CCMC, CCFI and other centres focused on this sector are making strong gains. The efforts in this sector should be continued.

5.5.4 Bridging Mechanism Recommendations

These are recommendations related to bridging the links between research centres and the private sector.

* Replicate Seabright – the Seabright model offers a good example of the manner in which universities can commercialize, transfer or license intellectual property and innovations. Similarly, the Seabright model represents a good model for the management of intellectual property. Given the need to improve the management of intellectual property in Atlantic universities, ACOA should fund efforts similar to Seabright for other regional universities. It is recommended that ACOA should fund the use of this model at other universities in the region.

* Parallel to NRC Institutes – should any of the potential NRC Institutes be established, ACOA should develop parallel initiatives to stimulate the local commercialization of NRC's efforts.

* Prism/Brokers – this group focuses the efforts of the university research community by matching it with the needs of private sector clients. CCFI and Concept+ work at least in part in this capacity. ACOA should consider directing its support to this function that utilizes our current infrastructure.

* Encourage a Culture Shift in Universities – ACOA should continue to push for a shift to the culture of research in universities. ACOA's funding has brought some researchers closer to industry and sensitized them to the needs of industry. This culture shift requires a consistent effort and this should be continued.

  To encourage this culture shift, some possible initiatives include:

  - linking funding for centres specifically to the provision of services for SME's.
  - establishing specific measureable objectives of centre performance to the success of their clients and economic impacts.
  - supporting initiatives aimed at fostering closer relations with the private sector.

* Improve Monitoring of Clients – universities and other non-commercial research centers need to better monitor the impact of their efforts. Not only is this information vital to ACOA it is also vital to centers to know what services provide the most impact. It will also give centers some real success stories that can help to sell their services and generate increased revenues.

* Conditional Licensing – where local receptor companies are not available ACOA should encourage conditional licensing arrangements that see a significant portion of the economic benefits accrue to the local economy. ACOA should assess the feasibility of making this a condition of funding the Seabright Model at universities in the region.

6 Management Response

Management is pleased to note the very positive impacts the report says ACOA has had in the area of innovation. However, the analysis is not as strong as one would have liked due in part to the lack of strong accountability frameworks being in place at the outset and less than adequate record keeping and follow-up by the client centres.

Management believes that the report contains useful information for guiding ACOA's support for innovation. The recommendations of the report are being addressed in the development of the Atlantic Innovation Fund and other initiatives in the area of innovation.